DOCUMENT RESUME

ED 400 168	SE 058 795

TITLE	Action for a Cleaner Tomorrow. A South Carolina Environmental Curriculum Grades K-8, Second Edition.
INSTITUTION	South Carolina State Dept. of Health and Environmental Control, Columbia.
PUB DATE	96
NOTE	608p.
AVAILABLE FROM	South Carolina Department of Health and Environmental Control, 2600 Bull Street, Columbia, SC 29201; Office of Solid Waste Reduction and Recycling, 800-SO-USE-IT.
PUB TYPE	Guides - Classroom Use - Teaching Guides (For Teacher) (052)
EDRS PRICE	MF03/PC25 Plus Postage.
DESCRIPTORS	Curriculum Guides; Elementary Education; *Environmental Education; *Interdisciplinary Approach; Junior High Schools; *Learning Activities; Middle Schools; *Natural Resources; Pollution; Recycling; Science Activities; *Waste Disposal
IDENTIFIERS	South Carolina

ABSTRACT

The goal of this curriculum is to teach children and their parents to think about their daily habits and to make environmentally responsible choices. The lessons and activities are divided by grade levels: K-1, 2-3, 4-5, and 6-8. Lessons in each grade level are designed to cover a range of student skills, subject areas, and environmental issues. An extensive resource section includes background information on specific issues at the state and global level and a glossary. Each lesson has a teacher's section which includes grade level, lesson focus, materials, teaching time, and vocabulary. Most lessons are interdisciplinary and include extension activities and ideas for individual and group action for environmental causes. Topics covered in the lessons include litter control, waste disposal, recycling, water pollution, and conservation of energy. (DDR)

****
*   Reproductions supplied by EDRS are the best that can be made   *
*   from the original document.   *
****

ED 400 168

Action for a cleaner tomorrow.

A South Carolina Environmental Curriculum Supplement

1996
Second Edition

PERMISSION TO REPRODUCE AND
DISSEMINATE THIS MATERIAL
HAS BEEN GRANTED BY
R. L. Chesley
TO THE EDUCATIONAL RESOURCES
INFORMATION CENTER (ERIC)

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)
☑ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.
- Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

Published by
the South Carolina Department of Health and Environmental Control
2600 Bull Street
Columbia, South Carolina 29201.

© 1996 South Carolina Department of Health and Environmental Control

For more information on how to obtain a copy of
Action for a cleaner tomorrow, a South Carolina Environmental Curriculum Supplement,
contact the Office of Solid Waste Reduction and Recycling at
1-800-SO-USE-IT.

Action for a cleaner tomorrow is printed on recycled paper

BEST COPY AVAILABLE

SE058795

State of South Carolina
Office of the Governor

David M. Beasley
Governor

Post Office Box 11369
Columbia 29211

FOREWORD

I am pleased to introduce *Action for a Cleaner Tomorrow: A South Carolina Environmental Curriculum.*

Action was developed by DHEC's Office of Solid Waste Reduction and Recycling in conjunction with a statewide team of teachers, the South Carolina Department of Education, Clemson University Extension Service and the state "Keep America Beautiful" affiliate.

The curriculum serves as an excellent example of what can be accomplished when various groups work together for a common goal. The first edition of the curriculum was introduced in 1994 and won two national education awards. *Action* has also received recognition from the United States Environmental Protection Agency's Region IV Office and is currently being adapted for use by other states. At home, response to the curriculum has been overwhelmingly positive, with more than 4,000 teachers having been trained to use *Action*.

The second edition promises to be just as successful, with current lessons having been updated and new lessons having been added covering a range of additional environmental topics.

Environmental education is critical to maintaining the quality of our life. As we meet the challenge of protecting our environment and natural resources, the fact is there is no more precious natural resource than our children. This project is for them.

Action for a Cleaner Tomorrow and projects like it are the tools needed today to cultivate the environmentally conscious adults of tomorrow.

It is indeed my pleasure to introduce this curriculum for use in South Carolina classrooms.

David M. Beasley

David M. Beasley

STATE OF SOUTH CAROLINA
DEPARTMENT OF EDUCATION

Dr. Barbara Stock Nielsen
STATE SUPERINTENDENT OF EDUCATION

Dear Teachers and Children of South Carolina,

The environment and quality environmental education are important to us and should be important to everyone. Only by prioritizing environmental education can we build a new environmental ethic and encourage responsible action. That is the ultimate benefit.

"Action for a cleaner tomorrow" is a curriculum designed by South Carolinians for South Carolinians. It is designed to give all of our students the knowledge, the information, and the skills to make informed and responsible decisions toward environmental problems that affect our beautiful state and our precious natural resources. This curriculum encourages investigation, analysis, and decision making about such environmental topics as solid waste management, recycling and the wise use of our resources.

We CAN make the difference and our students can become leaders of environmental consciousness. "Action for a cleaner tomorrow" will lead to a cleaner tomorrow and to a cleaner South Carolina.

Sincerely,

Barbara S. Nielsen

Barbara S. Nielsen, Ed.D.
State Superintendent of Education

1429 SENATE STREET COLUMBIA, SOUTH CAROLINA 29201 (803) 734-8492 FAX (803) 734-3389

UNITED STATES DEPARTMENT OF EDUCATION
THE SECRETARY

FOREWORD FOR SOUTH CAROLINA "ACTION FOR A CLEANER TOMORROW" SOLID WASTE MANAGEMENT AND RECYCLING CURRICULUM

BY RICHARD W. RILEY

From the glorious Appalachian mountains to the celebrated beaches of the Grand Strand and Lowcountry, South Carolina's natural resources are renowned worldwide. The beauty of our state contributes to a high quality of life for residents and attracts millions of visitors who boost our economy. It is critical that we protect our precious environment for ourselves and future generations.

With the adoption of the South Carolina Solid Waste Policy and Management Act of 1991, our state now has a comprehensive law to regulate the management of solid waste. One of its most important components requires a solid waste and recycling curriculum in our schools. "Action for a cleaner tomorrow," a curriculum developed specifically for South Carolina, is now a required course of study.

Experience has shown us that learning about the importance of protecting the environment and effective solid waste management can have a tremendous positive influence on the attitudes and habits of children and their parents. As conservation and recycling become customary, it is my hope that South Carolina's citizens will become her primary caretakers.

Richard W. Riley

Richard W. Riley
U.S. Secretary of Education

400 MARYLAND AVE., S.W. WASHINGTON, D.C. 20202-0100

Our mission is to ensure equal access to education and to promote educational excellence throughout the Nation.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IV
345 COURTLAND STREET N.E.
ATLANTA GEORGIA 30365

FOREWORD

One of EPA's goals for environmental education is to reach every home, school, and community across the nation with a message of environmental stewardship and a balanced view of the environmental issues. The best way to achieve this is through the cooperative efforts of not only federal, state, and local governments, but also business, education, and community organizations. No one organization can accomplish this on its own.

Action for a cleaner tomorrow: A South Carolina Environmental Curriculum represents one way this message can be delivered effectively. I am impressed not only with the scope of the subject matter covered, but also the process with which it was developed ensuring the integrity and broadest possible application of the materials. It is encouraging to see statewide efforts such as these which involve the collaboration of a broad cross-section of state and local environmental and educational groups. These types of partnerships and alliances are critical in the development and delivery of environmental education.

The curriculum is interdisciplinary and includes both in-class and at-home activities that will help students *and* their parents see the impact of their everyday behavior on the environment. Children can influence their parents to recycle at home, while parents can influence their children to compost their food scraps and yard trimmings. Students can influence their teachers to start or improve a school-wide recycling program, while teachers can influence their students to pursue environmentally related careers.

I am confident that the introduction of this curriculum in schools throughout South Carolina will provide a much needed catalyst for quality environmental education and will promote responsible environmental stewardship. Stewardship means taking responsibility for, caring for, and managing the earth's natural resources. Individual actions can and do make a difference. As students complete the activities, they will be able to carry the message of stewardship beyond the school and into their homes and the larger community across South Carolina. Learning and applying the principles of solid waste management and recycling outlined in this curriculum will contribute greatly to conserving and protecting our environment.

Richard D. Nawyn

Richard D. Nawyn, Chief
Environmental Education & Public Outreach

Action for a cleaner tomorrow.

A South Carolina Environmental Curriculum Supplement

CURRICULUM TABLE OF CONTENTS

Introduction i

Acknowledgements ii

How to Use *Action for a cleaner tomorrow* ix

Grade K-1 lessons
(See first page after the colored tab for K-1 Table of Contents) See *1st Colored Tab*

Grade 2-3 lessons
(See first page after the colored tab for 2-3 Table of Contents) See *2nd Colored Tab*

Grade 4-5 lessons
(See first page after the colored tab for 4-5 Table of Contents) See *3rd Colored Tab*

Grade 6-8 lessons
(See first page after the colored tab for 6-8 Table of Contents) See *4th Colored Tab*

Resource See *5th Colored Tab*

Glossary See *6th Colored Tab*

Books, Videos, and Other Information See *7th Colored Tab*

Action cleaner tomorrow.

A South Carolina Environmental Curriculum Supplement

Environmental issues are neighborhood issues. As good neighbors, we should recognize that simply going through our daily routines affects the world around us ... and we must teach our children responsible environmental habits.

Action for a cleaner tomorrow, a South Carolina environmental curriculum, has been developed to teach the children of South Carolina ... and, ultimately, their parents ... to think about their daily habits and to make environmentally responsible choices. The name of this curriculum, ***Action for a cleaner tomorrow***, is simply a reminder that practicing environmental responsibility is a matter of forever learning more about the world around us and taking action for a cleaner tomorrow.

This curriculum tries to reflect the environmental issues facing the world today with a particular emphasis on South Carolina's concerns and goals. By bringing the issues home ... to our state, community, and backyards ... the curriculum strives to show that *we* can make a difference. To provide a well-rounded study of South Carolina's environment, in addition to lessons on solid waste reduction and protecting our natural resources, this Second Edition of the curriculum supplement also includes activities on air and water quality, and energy.

The Curriculum Development Team consisted of representatives from the South Carolina Department of Health and Environmental Control's Office of Solid Waste Reduction and Recycling; a dedicated group of teachers representing all grade levels and subject matters, a cross section of both rural and urban areas, and public and private schools; representatives from the South Carolina Department of Education; and writing and design consultants, Haggard & White. The curriculum has been reviewed by and comments received from teacher pilot testing groups as well as various industry and environmental groups.

By receiving input from groups and individuals with varying experiences, the Curriculum Development Team strived to provide a broad informational base and a balanced view of environmental issues. And the issues are dynamic. As research continues and as technologies expand, the practices of waste disposal and environmental protection will change. *Action for a cleaner tomorrow* will be reviewed and revised as technologies and environmental issues evolve. We'd like to hear from you. We want to know what you and your students think, how you are using the lessons, what additional topics you would like covered, etc. To stay on our mailing list, return the comment sheet enclosed at the end of this curriculum.

Waste will be with us always. It's up to us ... and the next generations ... to develop and maintain responsible daily habits. We challenge today's teachers and students to take a stand and take "*Action for a cleaner tomorrow*."

Acknowledgements

Developing ***Action for a cleaner tomorrow*** has involved education, environmental, and communication experts from across South Carolina. The success of ***Action for a cleaner tomorrow*** is a result of the dedication and commitment of many people who care not only for the environment, but more importantly, for the children of South Carolina. The South Carolina Department of Health and Environmental Control's Office of Solid Waste Reduction and Recycling would like to acknowledge the efforts of these people for their assistance in preparing ***Action for a cleaner tomorrow***, South Carolina's environmental curriculum.

Curriculum Development Team

Core Committee

Lorraine Conrad, Chair
Science/Health Coordinator, Richland School District 2

Audrey Andrieski, *North Springs Elementary School*
Pat Bartholomew, *Springfield Elementary School*
Marcia Burckhalter, *Barnwell High School*
Jana DeHoff, *Saxe Gotha Elementary School*
Jane Etta Dion, *Pinewood Prep School*
Karen Durand, *J.B. Edwards Elementary School*
Don Franklin, *Wade Hampton High School*
Pamela Hanfland, *Conder Elementary School*
Jane Hayes, *Rock Hill Clean & Green*
Brenda Keeling, *Rawlinson Road Middle School*
Fran Kirby, *Batesburg-Leesville Elementary School*
Jim Laughner, *Porter Gaud School*
Mary McConathy, *Aiken County Public Schools*
Linda Mobley, *Richland Northeast High School*
Renee Potts, *Pendleton Junior High School*
Shirley Trebil, *Manning Elementary School*
June Wise, *W. E. Parker Elementary School*
Jettie Young, *Clinton Elementary School*

Alpha Pilot Testing Teachers

Kathleen Anderson, *Newington Elementary School*
Rebekah Baker, *Wood Elementary School*
Elizabeth Baldwin, *Summerville High School*
Charlene Brewer, *McKissick Elementary School*
Peggy Carey, *Hilton Head Primary School*
Diane Curlee, *Bowman Academy*
Joan Dukes, *McKissick Elementary School*
Allianne Duvall, *North Springs Elementary School*
Jerri Ferguson, *North Myrtle Beach Elementary School*
Eva Gaddy, *St. Johns High School*
Cynthia Gardner, *Gilbert Elementary School*
Linda Horrell, *Walterboro High School*
Linda Hudson, *Clinton Elementary School*
Mary Ann Moody, *Lake View Elementary School*
Judy Moser, *Greenbriar Elementary School*
Tina Oshima, *Socastee Middle School*
Sara Ann Pope, *Wood Elementary School*
Linda Price, *League Middle School*
Lynnette Richardson, *Lake View Middle School*
Lorie Sabol, *Saxe Gotha Elementary School*
Lenette Sawyer, *St. Johns Elementary School*
Mary Shumate, *Harold C. Johnson Elementary School*
Marty Simmons, *Hunter Street Elementary School*
Howard Snelling, *York High School*
Martha Stansell, *Liberty High School*
Esther Thomas, *Denmark-Olar Middle School*
Kathy Timms, *Fairfield Middle School*
Gail Twisdale, *Hilton Head Primary School*
Joanne Walsh, *League Middle School*
Grant Warwick, *West End Elementary School*
Carolyn Wimberly, *Guinyard Elementary School*

Beta Pilot Test Teachers

Dawn Allen, *Holly Hill Primary School*
Lillian Arnold, *South Kilbourne Elementary School*
Martha Barry, *Spaulding Elementary School*
Judy Baxley, *Williston-Elko Middle School*
Brenda Beasley, *Brewer Intermediate School*
Donna Belk, *Kinard Elementary School*
Tamara Bishop, *Fennell Elementary School*
Martha Brailsford, *C.E. Williams Middle School*
Betty Broadhum, *James F. Byrnes Academy*
Virginia Buchanan, *Westminster Christian School*
Mae Charles Byars, *Jonesville Elementary School*
Kiersten Byrd, *Finley Road Elementary School*
Willie Cain, *Blenheim Middle School*
Barbara Cely, *Allendale Elementary School*
Melissa Chance, *Estill Elementary School*
Linda Collins, *Bennettsville Elementary School*
Leslie Cope, *Carver Edisto Middle School*
Michelle Corvino, *DuBose Middle School*
Carole Cosper, *Fort Mill Elementary School*
Julia Cote, *Chester Middle School*
Deborah Davis, *Castle Heights Middle School*
Denise Davis, *Edwards Elementary School*
Terry Dennis, *Jackson Middle School*
Gerald Duvall, *Johnakin Middle School*
Rhonda Ewing, *Stratford High School*
Dan Feeney, *Oak Elementary School*
Judith Feeney, *Oak Elementary School*
Betty Felder, *Williams Middle School*
Connie Fiffick, *St. Peter's Elementary School*
Kay Friddle, *Parker Middle School*
Abraham Funchess, *John Ford Middle School*
Angela Gibbons, *Manning Elementary School*
Cathy Gilmore, *Leavelle McCampbell Middle School*
Linda Gordy, *North Augusta Middle School*
Paula Graham, *Jenkins Hill Elementary School*
Jackie Green, *Rawlinson Road Middle School*
Anne Hall, *Brewer Intermediate School*
Anne Halter, *Harbor View Elementary School*
Karen Harris-Sweetman, *Williston-Elko*
Middle School
Jeanne Hartley, *Lexington Middle School*
Sharon Harvley, *Iva Elementary School*
Patti Hinson, *Andrew Jackson Middle School*
Ann Holland, *Oakwood-Windsor Elementary School*
Lee Howell, *Jefferson Elementary School*
Carolyn Hughes, *Woodruff Elementary School*
Sheryl Jackson, *Angel Oak Elementary School*
Susan Jennings, *West Hardeeville Elementary School*
Joyce Jordan-Smith, *Rainbow Kindergarten*
Joyce Kale, *Bowman Elementary School*
Charlotte Karnes, *York Road Elementary School*
Carla Keasler, *Pendleton Junior High School*
Joyce Kimbrell, *Fort Mill Primary School*
Emma Caroline Kinney, *Latta Middle School*
Angela Kirkland, *Batesburg-Leesville Middle School*
Maureen Kondracki, *St. Peter's Elementary School*
Angie Lancaster, *Arcadia Elementary School*
Patricia Lanning, *St. Mary's Elementary School*
Princess Lipscomb, *Woodruff Primary School*
Debra Love, *Harold C. Johnson Elementary School*
Allison Lyles, *Griggs Road Elementary School*
Nancy Mabry, *Buffalo Elementary School*
Lara Lee Martin, *St. Helena Elementary School*
Linda Massey, *A. Birney Middle School*
Susan Massingill, *Calhoun Elementary School*
Carole McAfee, *West Pelzer Primary School*
Mary McConathy, *Oakwood-Windsor*
Elementary School

Beta Pilot Test Teachers, continued

Evelyn Misko, *Marrington Middle School*
Mary Anne Moody, *Lake View Elementary School*
Marsha Moon, *Finley Road Elementary School*
Beatrice Morris, *Hopkins Elementary School*
Carolyn Murphy, *Summit Parkway Middle School*
Pamela Nichols, *DuBose Middle School*
Gwen NiiLampti, *Felton Laboratory School*
Kim Noe, *Pontiac Elementary School*
Kathy O'Conner, *New Prospect Elementary School*
Diane Pace, *Shaw Heights Elementary School*
Sandra Parker, *St. George Elementary School*
Pat Pierce, *Myrtle Beach Elementary School*
Sheryl Pitts, *Dixie High School*
Denise Powers, *Jenkins Hill Elementary School*
Arlene Puryear, *Hollywood Elementary School*
Debbie Quesada, *Immanuel Childcare*
Melissa Rainsford, *Irmo Elementary School*
Veronica Ramseur, *Bradley Elementary School*
Diane Rawl, *Batesburg-Leesville Middle School*
Diane Rea, *Project Reach*
Mandy Reinert, *Southwood Middle School*
Lisa Roberts, *Harold C. Johnson Elementary School*
Frances Robertson, *Paul Knox Middle School*
Jeannie Rogers, *Hannah-Pamplico High School*
Susan Rowe, *Monroe Pinckney Middle School*
John Schweikart, *St. Paul's Country Day School*
Dianne Seminatore, *Fennell Elementary School*
Debbie Sessions, *Sanders Elementary School*
Julie Setzler, *Jennie Moore Elementary School*
Linnea Shick, *Ben Lippen School*
Sylvia Simpson, *Cheraw Elementary School*
Sandra Smith, *West Elementary School*
Deborah Smith, *Oakwood Middle School*
Natalie Spence, *White Knoll Elementary School*
Windy Spitz, *R.E. Davis Elementary School*
Meredith Spradley, *Richmond Drive Elementary School*
Michelle Starnes, *Hand Middle School*
Darlene Stowe, *St. John's Elementary School*
Bunny Summers, *E.L. Frierson Elementary School*
Sharon Thomas, *Berkeley Elementary School*
Sandra Thompson, *Ebeneezer Avenue Elementary School*
Marianne Tully, *St. Mary's School*
Sharon Valentine, *Laurens Junior High School*
Michelle Vastag, *Rawlinson Road Middle School*
Polli Vaughn, *Rawlinson Road Middle School*
Rosa Waddell, *Jonesville Elementary School*
Donna Whitesides, *Ronald McNair Junior High School*
Betty Williams, *Jefferson Primary School*
Wanda Wilson, *West Hardeeville Elementary School*
Terrell Wilson, *Maryville Elementary School*
Martha Woods, *D.P. Cooper Elementary School*
Meg Wrenn, *Andrew Jackson Elementary School*
Pam Zimmerman, *Sullivan Middle School*

Beta Pilot Test Teachers (Air, Water & Energy Lessons)

Melody C. Dorn, *Saluda Elementary School*
Patricia S. Geddings, *North Elementary School*
Pamela Hanfland, *Conder Elementary School*
Greta Hutchenson, *Oakland Elementary School*
Linda Mobley, *Richland Northeast High School*
Peggi Murray, *Saluda Elementary School*
Kim Noe, *Pontiac Elementary School*
Lynn M. Rivers, *North Elementary School*
Pam Seawell, *North Springs Elementary School*
Laurie Seawright, *Saluda Elementary School*
Laura P. Timmons, *Satchel Ford Elementary School*
Jodi Watjen, *Gaffney Senior High School*

Thank You

Thank you to all the high school teachers from throughout South Carolina who participated in the pilot testing of the 9 - 12 lessons and activities. Taking these lessons into the classroom provided us with a wealth of information. The teachers listed here gave their lime to attend the initial high school training sessions, to share several lessons with their students, and to provide comments.

Norma L. Ashburn, *Hanahan High School*
Jan Baker, *Pickens High School*
Stephen E. Bell, *Estill High School*
Daniel R. Beth, *Wade Hampton High School*
Ann Blackwell, *Travelers Rest High School*
Starr Bright, *Branchville High School*
Carrie Burgess, *Berea High School*
Wanda Bush, *Strom Thurmond High School*
Terry Cheatham, *Lexington High School*
Bob Crain, *Riverside High School*
Kim D. Dickerson, *Georgetown High School*
Carolyn Dickson, *North Augusta High School*
Patsy C. Drake, *Hillcrest High School*
Dennie Duke, *Williamsburg Academy*
Enid S. Duncan, *Spartanburg High School*
Ruben Fuller, *Mt. Pleasant High School*
Janice M. Gamble, *C.E. Murray High School*
Kathy Goolsby, *Northwestern High School*
Sandy Gresham, *Georgetown High School*
Claire L. Grogan, *Rock Hill High School*
Lucy M. Ham, *Mullins High School*
Linda Hammond, *Rock Hill High School*
Sandra Hannah, *Riverside High School*
Heather Hardin, *Rock Hill High School*
Leslie Hill, *Wade Hampton High School*
Ashley J. Hoffman, *Mauldin High School*
Judith Jackson, *MidCarolina High School*
Mary E. James, *Stratford High School*
Ray Kimbrell, *Northwestern High School*
Deloris K. Klug, *Westside High School*
Lynda Lamb, *Chapin High School*
Mary M. McGee, *Cresent High School*
John McGill, *Westminster High School*
Jim McNeill, *Silver Bluff High School*
Cheryl Y. Melton, *North Augusta High School*
Lynda Mills, *Clinton High School*
Deborah Minick, *Saluda High School*
Dawn Pursley, *Northwestern High School*
Jeannie Rodgers, *Hannah-Pamplico High School*
Bill Somerville, *Newberry High School*
Sue M. Steed, *Wando High School*
Judith D. Tarleton, *Northwestern High School*
Sandra L. Travis, *North Augusta High School*
Barbara Tyler, *Andrew Jackson High School*
Martha L. Ussery, *Andrew Jackson High School*
Claudia Warley, *Dorchester Academy*
Kim White, *Berea High School*
Stan Wilk, *FE Dubose Vocational School*
Alene Wilkins, *USC-Aiken*

South Carolina Department of Health and Environmental Control
Douglas E. Bryant, *commissioner*
R. Lewis Shaw, *deputy commissioner, Environmental Quality Control*
Robert W. King, Jr., *assistant deputy commissioner, Environmental Quality Control*
William W. Culler, *director, Division of Solid Waste Planning and Recycling*

Office of Solid Waste Reduction and Recycling
Stephen C. Thomas, *manager*
Richard Chesley, *public information director*
Mary Anne Banich, *assistant director of public information*
Jana White, *grants coordinator*
Sharon Thompson, *assistant grants coordinator*
Wanda Connelly Crotwell, *program information coordinator*
Tina Lindler, *environmental quality manager*
Angie Perry, *trainer*
Mary Margaret Mendenhall, *trainer*
Mohamed Abedelsalam, *Bureau of Air Quality*
John A. Chigges, *environmental quality manager, Bureau of Water Pollution Control*
Sally C. Knowles, *division director, Bureau of Water Pollution Control*
Larry E. McCullough, *manager, Bureau of Water Pollution Control*
Cathy C. Montgomery, *manager, Bureau of Drinking Water Protection*
Joe Rucker, *assistant bureau chief, Bureau of Drinking Water Protection*
Richard D. Sharpe, *manager, Air Program Section, Bureau of Air Quality*

South Carolina Department of Education
Linda D. Sinclair, *ed. assoc. - science, Off. of Technical Assistance, Div. of Curriculum*

Other Education Contributors
Dr. Lynn Altman, *science coordinator, Greenville County*
Dr. John R. Carpenter, *University of South Carolina*

For more information on water pollution, contact:
The Bureau of Water Pollution Control
Beth Miller, *Nonpoint Source Education*
(803) 734-0866
or by FAX (803) 734-5355

The Bureau of Drinking Water Protection
Janet Clarke, *Drinking Water Education*
(803) 724-6097
or by FAX (803) 734-4661

For more information on air pollution, contact:
The Bureau of Air Quality
Susan Provence, *Air Quality Education*
(803) 734-2862
or by FAX (803) 734-4556

For more information on energy, contact:
The S.C. State Energy Office
(803) 737-8030
or by FAX (803) 737-9846

Haggard & White
Communication Consultants
Becky Haggard & David M. White

The Office of Solid Waste Reduction and Recycling gratefully acknowledges the review and comments of Thom Berry, director, Division of Media Relations; Jan Tuten, public information director, Division of Media Relations; the staff of the Planning Secion of the Division of Solid Waste Planning and Recycling, Art Braswell, manager. Additional thanks to the Dr. Fran Wolak, Clemson Extension Service and Keep America Beautiful.

Tom Biga, Saluda County
Chip Boiling, Charleston County
Avanette Boular, Rock Hill Clean & Green
Lansing Brewer, Kershaw County
Julia Cagle, KAB of the Midlands
Joyce Christenbury, Clemson University
Ernie Church, Greenwood County
Birdie Crosby, Clemson Extension
Peggy Culler-Hair, Richland County
Robin Currence, Clemson Extension
Charles Davis, Clemson Extension
Leslie Hatchell, York County
Jane Hayes, Rock Hill Clean & Green
Elizabeth Hill, Greenville County
Cindy Hord, Chester County

Janis Hunter, Anderson County
Jack Keener, Clemson Extension
Georgeanne Kirven, Sumter County
Barbara Lewis, Clemson Extension
Susan Lowe, Horry County
Barbara O'Connell, Rock Hill Clean & Green
John Oxner, Kershaw County
Dolly Patton, Sandlapper Magazine
Nancy Schaaf
Calvert Sherard, Clemson Extension
Lila Smoak
Leslee Spivey, Clemson Extension
Debbie Strickland, Clemson Extension
Dianne Waddle, S.C. Clean and Beautiful
Meg Wrenn

The Office also gratefully acknowledges the help and support of Joyce Addison and Becky Starnes as well as the mailroom, printing and art departments.

How To Use
Action for a cleaner tomorrow.

Action for a cleaner tomorrow lessons and activities are divided by grade levels K-1, 2-3, 4-5, 6-8, and 9-12. Lessons in each grade level are designed to cover a range of student skills, subject areas, and environmental issues. Most lessons are interdisciplinary. Teachers are encouraged to review all the lessons and choose the ones that best reflect their students' abilities and the local issues. An extensive **Resource** section covering background materials provides a great deal of information on specific issues from both global and South Carolina perspectives. In addition to the Resource section are a Glossary and lists of books and videos available through various agencies including DHEC's Office of Solid Waste Reduction and Recycling.

A Step Back to Go Ahead

It is important to note that, since ***Action for a cleaner tomorrow*** is the first environmental curriculum supplement produced specifically for South Carolina, some of the topics and information will be new to students. Therefore, it may be necessary for teachers to go back and choose lessons from an earlier grade level to establish a foundation for learning more advanced concepts. However, since this is a curriculum for grades K-12 and students will be progressing through the curriculum as they progress through their grades, please do not move forward and select lessons from higher grade levels.

For ease of use, lessons have been designed to follow a specific format. For convenience, each lesson begins on a right-hand page.

Understanding the Teacher's Box

On every lesson, teachers will find the Teacher's Box in the upper left-hand corner of the first page of the lesson. In this box you will find:

- the appropriate **Grade** level
- **Focus** of the lesson
- **Subject** matter
- **Materials** - Materials listed in this box are for the primary teaching activity and may not be the materials needed for Extension Activities.
- approximate **Teaching Time**
- suggested **Vocabulary** - You will find these definitions in the Glossary.

Additionally, under the title of each lesson is an indicator of the level of teacher preparation for the lesson: **Easy-To-Do**, **Moderate**, or **Extensive**. This attempts to indicate *teacher preparation time and not the level of difficulty or the amount of classroom or research time for the students*. For example, an Easy-To-Do lesson may take only a few minutes of a teacher's time to prepare, but may take students several days to complete.

Understanding the Lesson Format

Lessons follow a format that lists:

- **Learning Objective** - This is a statement indicating what students should learn.
- **Background** - The Background information may be supplemented with information from the Resource section. This information is intended for the teacher to share with their students in language appropriate for their understanding.
- expanded **Materials** list - For lessons requiring an extensive list of materials, the Materials listing in the Teacher's Box will direct teachers to this list located in the text of the lesson.
- **Learning Procedure** - A step-by-step outline of the procedures for meeting the Learning Objective. Teachers will certainly want to adapt these procedures for their class and available resources. The Learning Procedure serves as a guide and is not intended to be a script.
- **Questions for the Class** - These may be leading questions and appear before the Learning Procedure to generate interest or they may be summary questions at the end of an activity. While not all lessons have suggested Questions for the Class, teachers will want to develop their own questions to meet the needs of their students.
- **Extension Activities** - These activities point to further exploration of the topic area. They may include independent student research or additional classroom projects. Note: the materials required for Extension Activities are not included in the list of materials in the Teacher Box at the beginning of each lesson.
- **Down To Earth** - While the curriculum focuses on the United States and South Carolina in particular, Down To Earth offers a global environmental perspective. This information covers a variety of general environmental topics not necessarily tied to the focus of the lesson. It is intended as an informational nugget for the teacher to share with students as appropriate.
- **Just Do It** - Just Do It suggests an action that students as individuals can perform at home with family or friends to make a difference.

Please note: this format is a guide. In some instances the format has been modified to fit the educational objectives. In other words, substance supersedes format.

In many cases, questions are posed for the students' consideration. Where appropriate, suggested answers have been provided and appear in italics immediately following the question. You will find pages to copy for student worksheets and handouts as well as pages that can be made into transparencies for overheads, etc.

***Action for a cleaner tomorrow* is action packed.**

This is an activity-based curriculum. Lessons encourage teachers and students to roll up their sleeves and make a difference. Whether you are building a compost pile, digging through the trash, making acid rain, or making recycled paper, you will find these lessons are hands-on activities that make students think for themselves ... to get their own facts ... to form opinions ... to make decisions ... and to take action.

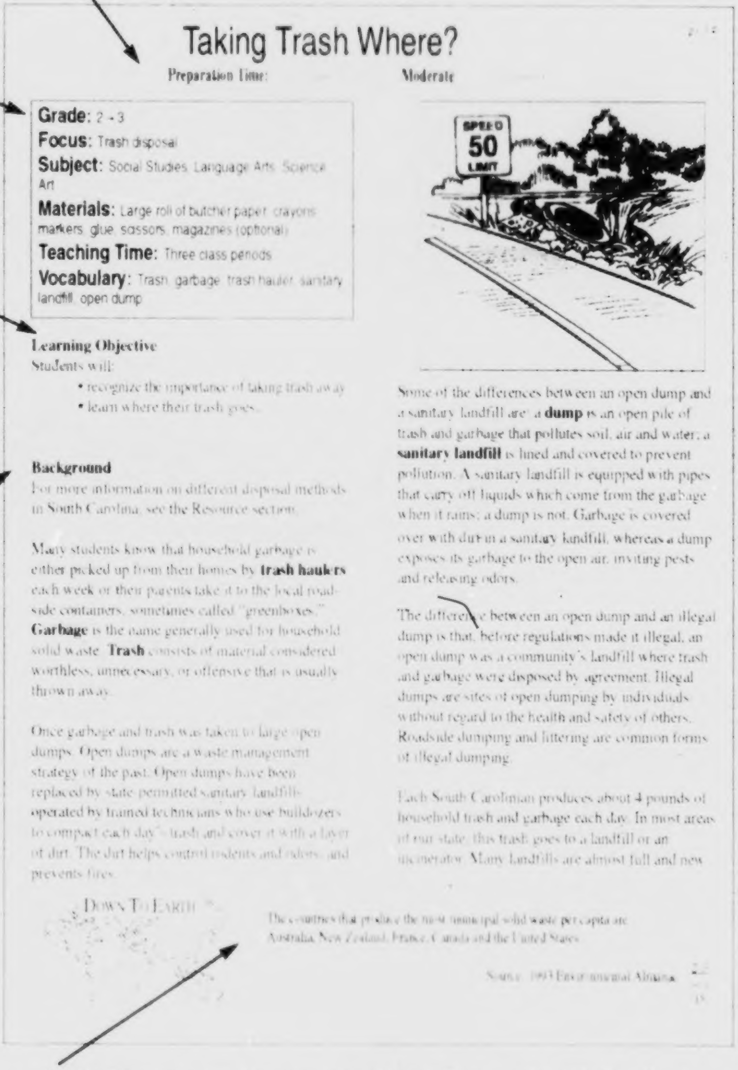
This curriculum should serve as a starting place for incorporating basic environmental education in your classroom, or for challenging students to learn more ... about their state, and the state of their environment.

Lesson title and estimate of teacher preparation time.

Teacher's Box offers, at a glance, the Grade Level, Focus, Subject, Materials, Teaching Time, and Vocabulary

Learning Objective is a brief statement that indicates what students should learn.

The **Background** information may be supplemented with information from the Resource section. This information is intended for the teacher to share with students in language appropriate for their understanding.



Taking Trash Where?

Preparation Time: **Moderate**

Grade: 2 - 3
Focus: Trash disposal
Subject: Social Studies, Language Arts, Science, Art
Materials: Large roll of butcher paper, crayons, markers, glue, scissors, magazines (optional)
Teaching Time: Three class periods
Vocabulary: Trash, garbage, trash hauler, sanitary landfill, open dump

Learning Objective

Students will:

- recognize the importance of taking trash away
- learn where their trash goes.

Background

For more information on different disposal methods in South Carolina, see the Resource section.

Many students know that household garbage is either picked up from their homes by **trash haulers** each week or their parents take it to the local roadside containers, sometimes called "greenboxes." **Garbage** is the name generally used for household solid waste. **Trash** consists of material considered worthless, unnecessary, or offensive that is usually thrown away.

Once garbage and trash was taken to large open dumps. Open dumps are a waste management strategy of the past. Open dumps have been replaced by state permitted sanitary landfills operated by trained technicians who use bulldozers to compact each day's trash and cover it with a layer of dirt. The dirt helps control rodents and odors, and prevents fires.

Some of the differences between an open dump and a sanitary landfill are: a **dump** is an open pile of trash and garbage that pollutes soil, air and water; a **sanitary landfill** is lined and covered to prevent pollution. A sanitary landfill is equipped with pipes that carry off liquids which come from the garbage when it rains; a dump is not. Garbage is covered over with dirt in a sanitary landfill, whereas a dump exposes its garbage to the open air, inviting pests and releasing odors.

The difference between an open dump and an illegal dump is that, before regulations made it illegal, an open dump was a community's landfill where trash and garbage were disposed by agreement. Illegal dumps are sites of open dumping by individuals without regard to the health and safety of others. Roadside dumping and littering are common forms of illegal dumping.

Each South Carolinian produces about 4 pounds of household trash and garbage each day. In most areas of our state, this trash goes to a landfill or an incinerator. Many landfills are almost full and new

DOWN TO EARTH

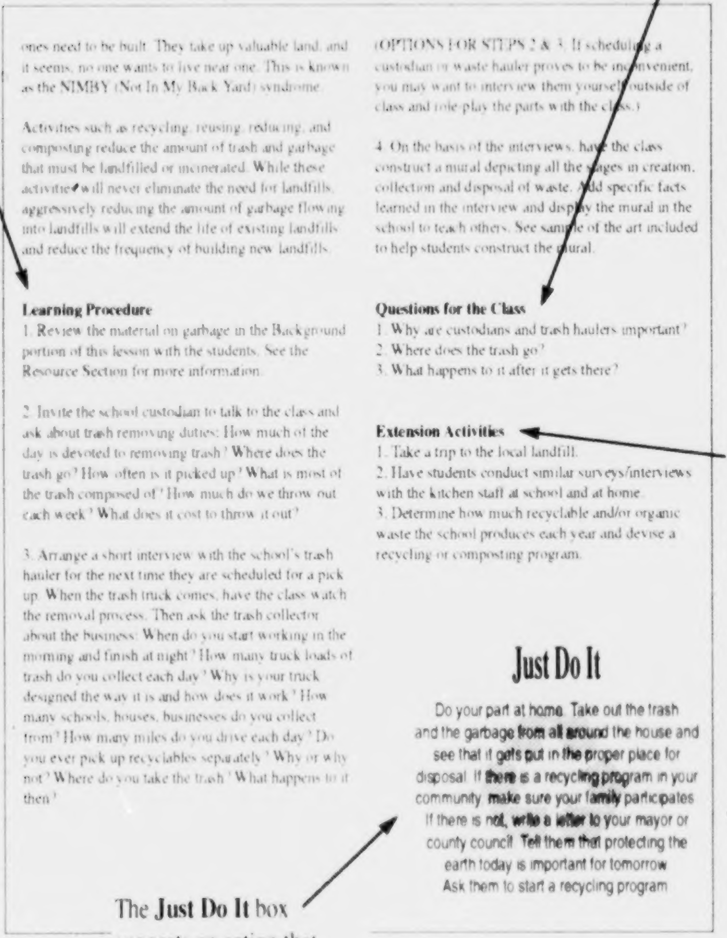
The countries that produce the most municipal solid waste per capita are Australia, New Zealand, France, Canada and the United States.

Source: 1993 Environmental Almanac

While the curriculum focuses on the United States and South Carolina in particular, **Down To Earth** offers a global environmental perspective. This information covers a variety of general environmental topics not necessarily tied to the focus of the lesson. It is intended as an informational nugget for the teacher to share with students as appropriate.

Questions for the Class may be leading questions and appear before the Learning Procedure to generate interest or they may be summary questions at the end of an activity. While not all lessons have suggested Questions for the Class, teachers will want to develop their own questions to meet the needs of their students.

Learning Procedure A step-by-step outline of the procedures for meeting the Learning Objective. Teachers will certainly want to adapt these procedures for their class and available resources. The Learning Procedure serves as a guide and is not intended to be a script.



ones need to be built. They take up valuable land, and it seems, no one wants to live near one. This is known as the NIMBY (Not In My Back Yard) syndrome.

Activities such as recycling, reusing, reducing, and composting reduce the amount of trash and garbage that must be landfilled or incinerated. While these activities will never eliminate the need for landfills, aggressively reducing the amount of garbage flowing into landfills will extend the life of existing landfills and reduce the frequency of building new landfills.

Learning Procedure

1. Review the material on garbage in the Background portion of this lesson with the students. See the Resource Section for more information.

2. Invite the school custodian to talk to the class and ask about trash removing duties: How much of the day is devoted to removing trash? Where does the trash go? How often is it picked up? What is most of the trash composed of? How much do we throw out each week? What does it cost to throw it out?

3. Arrange a short interview with the school's trash hauler for the next time they are scheduled for a pick up. When the trash truck comes, have the class watch the removal process. Then ask the trash collector about the business: When do you start working in the morning and finish at night? How many truck loads of trash do you collect each day? Why is your truck designed the way it is and how does it work? How many schools, houses, businesses do you collect from? How many miles do you drive each day? Do you ever pick up recyclables separately? Why or why not? Where do you take the trash? What happens to it then?

(OPTIONS FOR STEPS 2 & 3: If scheduling a custodian or waste hauler proves to be inconvenient, you may want to interview them yourself outside of class and role-play the parts with the class.)

4. On the basis of the interviews, have the class construct a mural depicting all the stages in creation, collection and disposal of waste. Add specific facts learned in the interview and display the mural in the school to teach others. See sample of the art included to help students construct the mural.

Questions for the Class

1. Why are custodians and trash haulers important?
2. Where does the trash go?
3. What happens to it after it gets there?

Extension Activities

1. Take a trip to the local landfill.
2. Have students conduct similar surveys/interviews with the kitchen staff at school and at home.
3. Determine how much recyclable and/or organic waste the school produces each year and devise a recycling or composting program.

Just Do It

Do your part at home. Take out the trash and the garbage from all around the house and see that it gets put in the proper place for disposal. If there is a recycling program in your community, make sure your family participates. If there is not, write a letter to your mayor or county council. Tell them that protecting the earth today is important for tomorrow. Ask them to start a recycling program.

Extension Activities point to further exploration of the topic area. They may include independent student research or additional classroom projects. Note: the materials required for Extension Activities are not included in the list of materials in the Teacher's Box at the beginning of each lesson.

The **Just Do It** box suggests an action that students as individuals can perform at home with family or friends to make a difference.

BEST COPY AVAILABLE

A PROCEDURAL NOTE FOR TEACHERS:

These activities have been designed to supplement South Carolina's environmental curricula and with the opportunities and limitations of the classroom teacher in mind.

It is your prerogative to adapt these lessons to your specific classroom situation. Although these lessons have been pilot tested, the developers realize ... and expect ... you, the teacher, may have to modify, supplement, or adjust the learning procedures, materials, work sheets, questions, vocabulary, etc., to meet the needs and learning experiences of your students.

We welcome your suggestions and comments so that all of South Carolina's students can benefit from *Action for a cleaner tomorrow*. Please keep us informed by using the Comment Form supplied with your copy of *Action for a cleaner tomorrow*.

A CAUTIONARY NOTE:

Some activities involve chemicals, glassware, flames, live specimens, etc. Please ensure that you and your students take proper precautions and follow accepted safety procedures. Be sure to read and identify safety precautions before starting an activity.

Name of Activity Reviewed: ______________________________

Action
for a
cleaner tomorrow.

A South Carolina Environmental Curriculum Supplement

Action for a Cleaner Tomorrow Evaluation Form

Thank you for participating in the review of *Action for a Cleaner Tomorrow*, the South Carolina Solid Waste Curriculum Supplement. Please complete an evaluation form for each lesson on which you wish to comment. Please feel free to copy this form as many times as you need. Please complete this form as soon as possible after teaching the lesson in your class. This form and your copies of the lessons (only if they contain notes and suggestions) should be returned to the address on the back of this form.

Rating Scale

	Excellent				Poor
Format:					
1) Is the curriculum easy to read?	1	2	3	4	5
2) Is the curriculum easy to use?	1	2	3	4	5
Evaluate the following format components:					
3) Teacher Information Box (top left of page one of lesson)	1	2	3	4	5
4) Down to Earth (at the bottom of some pages)	1	2	3	4	5
5) Just Do It (at the end of some lessons)	1	2	3	4	5
6) Extension Activities (included with some lessons)	1	2	3	4	5
7) Questions for the Class (included with some lessons)	1	2	3	4	5
Activity effectiveness:					
8) Overall effectiveness in accomplishing stated learning objective	1	2	3	4	5
9) Grade level/Vocabulary appropriateness	1	2	3	4	5
10) Background material	1	2	3	4	5

Your ideas for improving Background materials: ______________________

____

____

____

11) Learning procedure	1	2	3	4	5

Your ideas for improving Learning procedure: ______________________

____

____

Students' evaluation:					
12) Students' interest in this activity	1	2	3	4	5
13) Students' understanding of concepts presented	1	2	3	4	5
14) Students' interest in environmental education	1	2	3	4	5

Are listed materials reasonable/easy to collect YES ☐ NO ☐

Your ideas for improving Materials: ______________________________

____

____

Was the Preparation Time listed at the top of this lesson appropriate? YES ☐ NO ☐

Did you use the Resource Section provided with your lessons? YES ☐ NO ☐

Your ideas for improving the Resource Section: ______

Would you recommend this lesson to your colleagues?
Why or why not? ______

How did you incorporate this lesson into your classroom? (Did you coordinate this with text books or other materials; use books, films, videos, etc.? Which ones? Please be specific.) ______

Ideas for improving this lesson: ______

Are there any factors that limit your ability to use this curriculum in your classroom? ______

Please Print.

To assure you receive proper credit for your efforts, please return this form with your lessons.

Your Name: ______

Your School's Name: ______

Your Address: ______

Your Phone Number: ______

Subject Taught: ______ Grade Level: ______

Thank You!

Please complete and return this form to:
Haggard & White, Attn: Action for a Cleaner Tomorrow.
11 Whithorn Way, Blythewood, South Carolina 29016.

Action for a cleaner tomorrow.

A South Carolina Environmental Curriculum Supplement

I've been trained to use *Action for a cleaner tomorrow*, but have a new address. Please send any new lessons or updated information to the address listed below.

Please send this information to my ☐ Home Address ☐ School Address

My Name: ______________________________

My Home Address: ______________________________

____

My School's Name: ______________________________

My School Address: ______________________________

____

My Phone Number: ______________________________

Subject Taught: ____________________ Grade Level: ____________________

☐ I want to share *Action for a cleaner tomorrow* with my colleagues.
Please contact me about scheduling a training session.

seal with tape

(please fold here)

Please place
stamp here.

S.C. DHEC
Office of Solid Waste Reduction and Recycling
2600 Bull Street
Columbia, South Carolina 29201

(please fold here)

seal with tape

Annual Environmental Competitions Encourage Students To Take an Active Role in Protecting the Environment

With the goal of encouraging students to preserve our environment, the South Carolina Department of Health and Environmental Control began a statewide educational component to Nonpoint Source water pollution in 1992. Funded through Section 319 of the Clean Water Act, the charge was to develop a comprehensive educational program to make South Carolinians aware of the part people play in contributing to water pollution. One of the approaches taken to raising public awareness was by developing programs and activities primarily geared toward partnerships and focusing on encouraging young people to become more environmentally conscious.

The **Champions of the Environment** program was an evolutionary process that began with the South Carolina Environmental Awareness Student Awards Competition for middle school students and expanded into a recognition program for students involved in environmental projects and activities at all grade levels. This two-part program is continuing its outreach activities throughout the state in a series of environmentally-oriented television spots geared toward erasing the environmental education deficit, particularly in the areas of Nonpoint Source water pollution. By producing and broadcasting television spots aimed at motivating South Carolinians to act in a more environmentally-conscious manner and implement best management practices, we will continue our goal of alleviating Nonpoint Source water pollution.

Creating a partnership with Union Camp, DuPont, WIS-TV and Riverbanks Zoo, corporations who shared similar perspectives in protecting South Carolina's natural heritage and instilling in students the need to make an environmental commitment, was a key to the program's success.

The goals of the partnership are (1) to support and enhance environmental problem solving; (2) to develop student interest in science and math education and careers; (3) to reinforce environmental achievement through positive public recognition; (4) to support the development of interdisciplinary skills; (5) to encourage personal responsibility for the health of the environment; and (6) to reward creativity and innovation for environmental projects with statewide recognition and scholarships.

The middle school component of the Champions program, called the South Carolina Environmental Awareness Student Awards Competitions, incorporates five categories of competition and culminates each April at Riverbanks Zoo in Columbia. These competitions areas include environmental awareness poster, essay, spokesperson, bowl, and project.

Champions of the Environment Scholarship Recognition Program (for students in grades 1 through 12)

This component of the **Champions of the Environment** program recognizes outstanding environmental students with a television spot showcasing the student wearing the Champions medallion. The program is open to students in all grade levels who are actively seeking solutions to environmental problems. These students may work individually, as a team or as a classroom project.

The program works this way: (1) nomination forms are distributed to science teachers and others during September; (2) television spots begin with information regarding the nomination process; (3) nominations are received beginning in October, with a deadline for the 25th of each month for selecting the monthly **Champions of the Environment;** (4) the partnership advisory committee (representatives from Union Camp, DuPont, WIS and DHEC) meets and selects the monthly winners; (5) the winners tape the television spot at WIS and other locations in the Columbia area; (6) the spots are shown 25 times during the month; and (7) during May the monthly winners are evaluated to determine the scholarship recipients.

The television spots are broadcast by WIS-TV to the forty counties the station serves. It is estimated that each month the television spots reach 1,700,000 people.

At the end of the school year, the three most outstanding Champions (individuals or teams) will be chosen from the monthly winners and will be presented with $1000 scholarships during an awards reception. If a winning Champion is a team, the team will share the $1000 award.

The continuing goals of the cooperative public-private partnership are (1) to support and enhance environmental problem solving; (2) to develop student interest in science and math education and science careers; (3) to reinforce environmental achievement through positive public recognition; (4) to support the development of interdisciplinary skills; (5) to encourage personal responsibility for the health of the environment; and (6) to reward creativity and innovation for environmental projects with state recognition and scholarships.

Champions of the Environment develops student initiative and self-esteem through (1) peer recognition; (2) rewards through scholarship and personal achievement; (3) promotion and encouragement of environmental awareness, environmental leadership, and environmental conservation; (4) individual and group creativity; and (5) self-confidence and public speaking development.

The program is nationally recognized for its innovative approach to environmental education. **Champions of the Environment** program promotes hands-on learning by recognizing students working on exemplary environmental projects beyond the usual realm of the classroom.

For additional information on the program contact Phil Hayes, **Champions of the Environment** coordinator, SCDHEC, 2600 Bull Street, Columbia, SC 29201 or call (803) 734-5078.

South Carolina Environmental Awareness Student Awards Competition
(for students in grades 6 through 8)

Each year South Carolina's sixth, seventh, and eighth grade students are invited to demonstrate their environmental knowledge during the annual South Carolina Environmental Awareness Student Awards Competition in the Education Building and Amphitheatre of Riverbanks Zoological Park and Botanical Garden in Columbia. The event is usually scheduled in April around Earth Day.

If you are a sixth, seventh, or eighth grade teacher in South Carolina, we would like for you to encourage your students to participate in this environmental recognition program. We encourage you to show your concern and become active in protecting our precious natural resources.

There are several ways this can be done. The South Carolina Environmental Awareness Student Awards Competition has five divisions of competition with awards given in each area. These divisions are: (1) Environmental Awareness Poster; (2) Environmental Awareness Essay (500 words); (3) Environmental Awareness Bowl; (4) Environmental Awareness Spokesperson; and (5) Environmental Awareness Project. You may enter any or all divisions.

The essay, poster, project and spokesperson has a theme each year and should address the theme. The registration deadlines are determined in September of the year preceding the competitions and are available through the **Champions of the Environment** coordinator at DHEC.

Everyone entering the competition will be rewarded. Each participant will receive an Environmental Awareness Certificate for participating in the competition, personally commending the student for his/her efforts.

The four finalists in each division will be awarded $100 savings bonds and the winners will receive $300 savings bonds.

For additional information, including application forms, contact Phil Hayes, Coordinator, Champions of the Environment, SCDHEC, 2600 Bull St., Columbia, SC 29201, or call (803) 734-5078.

Essay Topic and Guidelines

(1) The essay topic is determined in September, prior to the April competition. (2) The essay length is 500 words (approximate) and should be typed (double-spaced) or neatly handwritten. If it is handwritten, it should be in ink and double-spaced on white paper, one side only. (3) Attach the entry form to your essay. Do not put your name on the essay, only on the entry form. (4) Essays become the property of DHEC and will not be returned. (5) Essays must arrive at DHEC by the announced deadline.

Poster Topic and Guidelines

(1) The topic for the poster competition is determined in September. (2) The size of the poster is 22" x 28." A third dimension may not be used. (3) Attach the entry form to the back of the poster. Do not put your name on the front of the poster. (4) Posters may be submitted on the day of the annual competition or may be delivered to DHEC prior to the competition. (5) Posters become the property of the South Carolina Department of Health and Environmental Control and will not be returned.

Environmental Awareness Bowl Guidelines

(1) Pre-registration is required for this competition and is limited. Students must be enrolled in the sixth, seventh, or eighth grade. (2) All participants qualify for the bowl by taking an environmental awareness quiz. The qualifying quiz is scheduled during the morning of the competition. Those students receiving the highest scores will become the finalists for the bowl taking place in the afternoon. (3) The competition's content areas include South Carolina's natural resources, water, soils, forestry, recycling, aquatic ecology, and current environmental issues.

Environmental Awareness Spokesperson

(1) The topic of the spokesperson category is announced in September prior to the April competition. (2) The participant will present a 45-second (time limit) commercial on the topic. The commercial must be presented live. Video commercials may not be substituted. (3) Hand-held props are permissible. (4) The competition will be judged on presentation, creativity, content, and effectiveness.

Environmental Awareness Project

The Environmental Awareness Project may be an individual, team (five maximum) or classroom project conducted during the school year to promote environmental awareness and participation. The theme for the project will be announced in September prior to the April competition. The five-page written entry (maximum typewritten) will be submitted by the announced deadline, and should include a project statement, documentation, publicity, and results. Graphs, videos, and photographs may be included as supplemental materials. During the day of the competition, the individual or team (five maximum) will present their project to a panel for final selection. There is a five minute limit on the presentation. The presentation may be followed by questions from the judging panel. The competition will be judged on the written report, presentation, creativity, and results.

Action
for a
cleaner tomorrow

TABLE OF CONTENTS
GRADES K – 1

Title	Discipline	Focus	Page
Natural or Human-Made	Social Studies, Science	Litter	1
Bangalee and the Litter Critters	Language Arts	Litter	3
Bag Some Litter	Art, Social Studies	Litter	5
Help I Can't Get It Off!	Science, Language Arts	How Litter Affects Animals	7
Hazards At Home	Science, Language Arts	Household Hazardous Products	11
Take It Away	Music, Social Studies, Science, Language Arts	Garbage	15
Where Trash Goes	Social Studies, Science	Trash Disposal	17
Clean or Dirty	Science, Health	Pollution of Natural Resources	19
Life in a Fish Bowl	Science, Language Arts	Water Pollution	21
What's a Cycle?	Science, Language Arts	Recycling	25
Recycle It	Social Studies	Recycling	29
What's Recyclable?	Social Studies, Science	Recycling	33
Giving Trees A Second Chance	Social Studies, Science, Performing Arts	Conserving Natural Resources	37
Too Many Wrappers	Social Studies, Art, Math.	Packaging	43
Lunchroom Trash	Health, Science	Reducing Trash	47
(Re)Show & (Re)Tell	Art, Language Arts	Reusing to Reduce Trash	51
Yesterday's Paper	Science, Language Arts	Reusing Things	55
A Rotten Idea	Science	Composting	59
My Body Needs Water	Science, Health, Art	Water	63
What's Energy	Science	Energy & Conservation	65

Natural or Human-Made?

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: K - 1

Focus: Natural and human-made things in our environment

Subject: Social Studies, Science

Materials: Natural items: leaves, rocks, seeds, fruit, wood; and human-made items: pencil, book, glass, cardboard, plastic bags, etc., and a box

Teaching Time: One to two class periods

Vocabulary: Natural, human-made

Learning Objective

Students will:

- distinguish between things that occur naturally in our environment and things that have been made.

Background

Ultimately, everything we use comes from natural resources, materials that are naturally occurring in the world around us. It's important that we learn to recognize the difference between items that are natural and those that are human-made, that is, natural objects that, through some human manufacturing process, have been changed into another object. This is the first step in recognizing the importance of our natural resources. For more information to accompany this lesson, see the Resource section.

Learning Procedure

1. Gather a variety of materials that are produced by nature – **natural** – and things made by people – **human-made**. You may bring these things to class or ask students to bring items to school.

2. Make simple graphic display signs to indicate the two categories, "natural" and "human-made." For example, the natural sign might include a tree with the sun overhead and the human-made sign might be a simple stick figure.

3. Looking at the signs have students discuss the difference between things that are natural and human-made.

4. On a table, group items into two piles, one natural the other human-made. Place the correct sign behind each pile. One at a time, hold up items and ask students to explain why the item is considered natural or human-made. *(Note: items that are produced by people using natural materials are classified as human-made. This would include items such as pencils or paper.)*

3. Take all items off the table and mix them up in a big box. Ask a student to pull an item out of the box and place it next to the correct sign, natural or human-made. Continue until all items have been categorized or until all students have participated.

4. Lay all items on a table. Instruct the students to use their senses of touch and smell only to determine natural from human-made items. **Ask:** Can senses of touch and smell be used to distinguish natural and human-made objects?

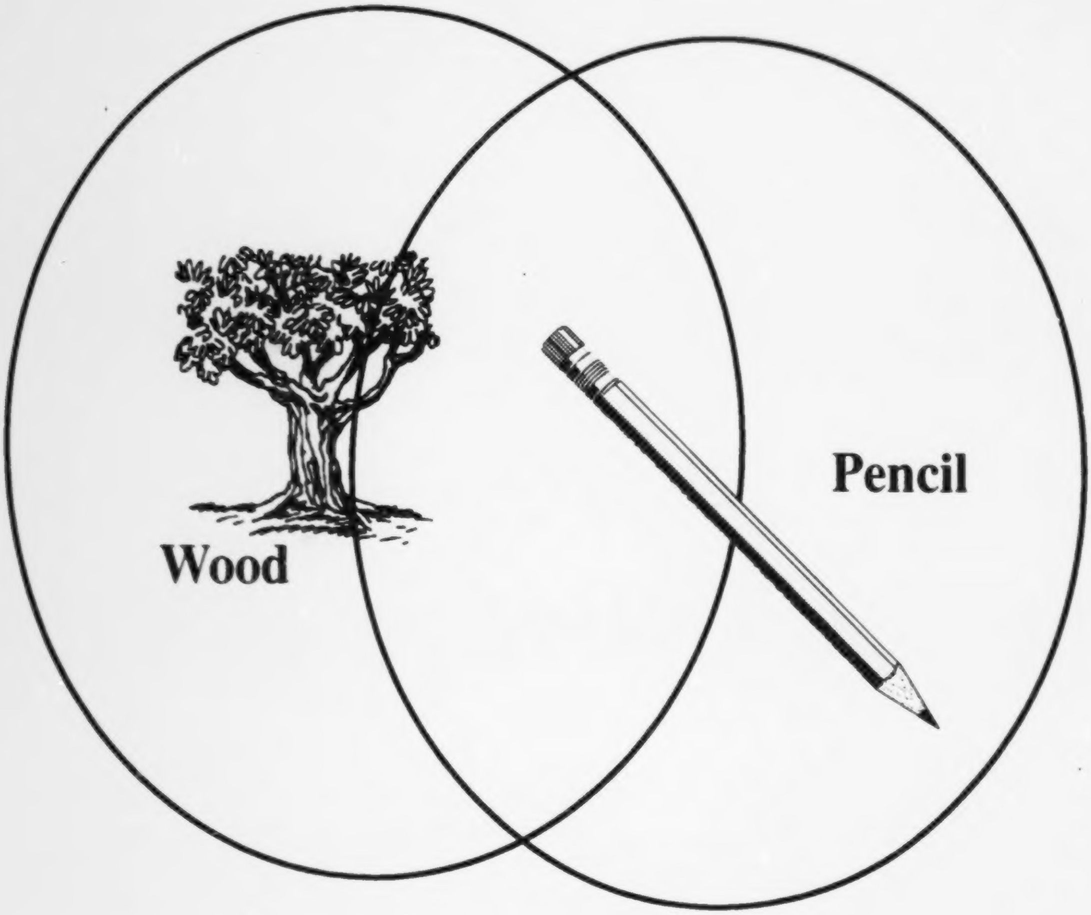
5. Develop a learning center to display natural and human-made objects brought in by students. Each day have one student bring in two items for the center. The student should sort the items into the proper category.

Extension Activities

1. Take a nature hike and have students pick up samples of natural materials such as leaves, rocks, etc. Make a classroom poster of natural items.

2. Make a "feelie" box by cutting a hole in a box just big enough for a child's hand. Put an object in the box. Instruct students to try to determine by touch alone whether the object in the box is natural or human-made. Change the item often and keep the box in your learning center with the other display.

3. For more advanced students, you might want to discuss the concept that some objects, such as a pencil, are both natural and human made. Use the following diagram as a guide the help them think of similar things.



Bangalee & The Litter Critters

Preparation Time: **Easy-To-Do** Moderate Extensive

Grade: K - 1
Focus: Litter
Subject: Language Arts
Materials: The book, *Bangalee* by Stephen Cosgrove, Price Stern Sloan, 1988
Teaching Time: 30 minutes
Vocabulary: Environment, litter, trash

Learning Objective

Students will:

- describe the effects of littering
- realize that cleaning up provides many benefits.

Background

Litter is a problem in South Carolina. Litter is harmful to people and animals and ruins the natural beauty of our land. South Carolina has strict laws against littering with fines as high as $1,000. To help combat the litter program in South Carolina, the South Carolina Department of Transportation has instituted an Adopt-A-Highway program where volunteers regularly clean up a stretch of roadside. (See the Resource section for more information.)

Learning Procedure

1. Introduce the term **environment**. The environment is everything around us. At school our environment is the classroom, the lunchroom, the playground, etc. At home our environment is different. **Ask:** can you name items from your school environment? Your home environment?

GRUNK
ALERT

2. Discuss the importance of keeping the environment clean. Ask students what happens when the environment is not clean. Introduce the terms litter and trash. Explain that **litter** is waste put in the wrong place such as on the ground, under bushes, or on the sidewalk. **Trash** is waste put in the right place such as in a trash can, dumpster, trash truck, or box for waste.

3. Read the book, *Bangalee*, to the class. This book tells the story of Kritter Castle which is surrounded by litter. Furry creatures – the Kritters – live in the castle and are dirty and messy. They litter and this litter causes them problems. Bangalee is different though. He always cleans up. The Kritters make fun of him for this.

In 1970, the United States government created the Environmental Protection Agency (EPA) to protect the environment from pollution.

Later, when Grunk, a garbage-eating monster, threatens the castle, the Kritters learn that cleaning up and keeping clean is a good idea.

4. Have the class act out action from the book. Divide the class into two groups, the Kritters and the Bangalees. Give the Litter Kritters bags of trash (clean litter such as scrap paper) to litter. Give the Bangalees trash bags to collect litter. The bangalees may also want to use other props such as brooms, dust pans and cleaning cloths. Read the story again and have students act out their roles. The teacher assumes the role of Grunk.

5. Have students describe the way they felt in their roles. Have students switch roles and try the story again. Ask students which role they liked best. Have students suggest ways they can prevent littering in their environment – classroom, home, park, and neighborhood.

Questions for the Class

1. What was the environment like at Kritter Castle?

2. What kinds of things did the Kritters litter?

3. Why did the Kritters laugh and make fun of Bangalee?

4. What made the Kritters clean up and stop littering?

5. Why were the Kritters afraid of the Grunk?

6. If the Grunk came to your class, what would it find?

Extension Activities

1. Have the class develop a class or school litter critter (mascot) of their own to promote litter prevention. Students could submit their suggestions for a litter mascot and vote on the one they like best. This litter mascot could be designed into a puppet, coloring book, poster, billboard, or costume.

2. Have a Grunk Alert in the classroom. This may be a horn that is sounded or simple sign that can be turned over to warn the class when there is litter that needs to be cleaned up. Offer a reward to the class if they can go a certain period of time, such as one day or one week, without the Grunk Alert going off in the class.

Teacher Note

If the book, *Bangalee* by Stephen Cosgrove, used in this lesson is not available in your library, call the S.C. DHEC at 1-800 76-USE IT. They have several copies available to loan.

Just Do It

Display your school or classroom litter critter mascot items (poster, puppets, coloring book, etc.) at the local mall to encourage everyone to stop littering!

Bag Some Litter

Preparation Time: **Easy-To-Do** Moderate Extensive

Grade: K-1
Focus: Litter
Subject: Art, Social Studies
Materials: Rough scale map of school grounds (or local area good for finding litter) divided into five areas, gloves from home, trash bags for collecting litter
Teaching Time: One class period
Vocabulary: Litter, pollution

Learning Objective

Students will:

- see that their actions make a difference in helping to solve our solid waste problems.

Learning Procedure

1. **Ask:** Do you see **litter**, or trash that has been discarded improperly, on your way to school or in your neighborhood? What kind? Why do you think people litter? (See the Resource section for more information on litter.)

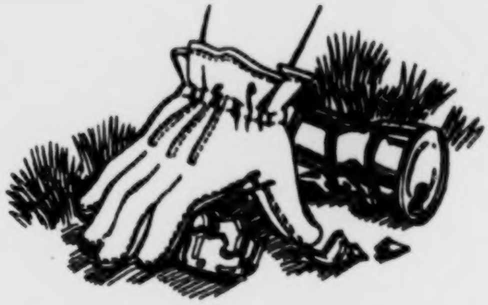
2. Tell students that they are going on a trash hunt. Divide the students into five groups and give each group a trash bag for collecting litter. Have students put on their gloves. Instruct students NOT TO PICK UP ANY GLASS OR SHARP OBJECTS. You may have them call you over to pick up these items and collect them in a special bag. Send each group to a designated area of your map. If you plan to take students to a large area, you will need to have several parents join you to help supervise.

3. After the allotted time, have students return to the class and have each group sort through their bag. Identify the types of litter they collected.

4. (Option: Graph the different kinds and amounts of litter you found.)

Question for the Class

1. What kinds of litter did you find? How much was there? Did you expect to find more? Or less?



2. Where do you think the litter came from?

3. Did some areas have more litter than others? Why?

4. Were different kinds of litter found in different areas?

5. What is wrong with littering? Does it pollute? Is it ugly? Can it be dangerous?

6. As a class brainstorm ways to reduce litter around your school.

Extension Activities

1. Read *The Wartville Wizard* by Don Madden, the story of a man given the power to make litter fly back to the person who threw it away.

2. Have groups create a collage of interesting textures and shapes from the litter they collected. Glue litter to posterboard. Let students add paint or use other art techniques to finish their collage.

3. Enjoy this Little Litter Poem! Have students make up their own verses.

Can on the street is not too neat,
Ugly litter I kick with my feet.

I see a bottle beside that gate.
Recycle it now, Don't you wait!

That paper's from a burger and drink –
Litter is ugly, Don't you think.

Action for a cleaner tomorrow.

A South Carolina Environmental Curriculum

For more information about South Carolina and the environment. call the
South Carolina Department of Health and Environmental Control at
1-800-768-7348.

Help! I Can't Get It Off

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: K - 1
Focus: How litter affects animals
Subject: Science, Language Arts
Materials: Six puppets, sandwich bags, milk jug, dental floss, foam cup, puppets, plastic six-pack rings, aluminum cans
Teaching Time: 30 minutes a day for several days
Vocabulary: Marine debris, trash

Learning Objective

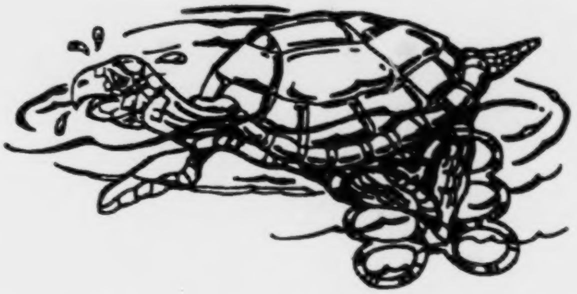
Students will:

- learn the importance of keeping our waters free from litter because of the potential harm to marine life.

Background

Another name for **trash** is litter or garbage, but as it hits the water it is known as "**marine debris.**" Marine debris has become such a concern that organized beach litter sweeps are held each year on the third Saturday in September in South Carolina. In the 1992 South Carolina Beach Sweep/River Sweep, about 8,000 volunteers removed more than 83 tons of debris from South Carolina's beaches, estuaries, lakes, rivers, creeks, and boat landings. The event was the largest one-day cleanup of the state's waterways in South Carolina's history.

Individuals, families or groups such as scouts, civic and church groups, school organizations or special interest clubs may volunteer for next year's beach sweep by calling 1-800-851-8899. Volunteers may select any waterway to clean. Information from last year's sweep, plastic, particularly cigarette butts, was the most abundant item on the beach. Cigarette butts are not made of paper, as commonly believed, but of cellulose acetate which may take 75 years or longer to degrade.



This short puppet show illustrates to young children the potential harm their litter can pose to innocent creatures living beneath the waves.

Learning Procedure

Note: You may want to work with an older class to produce this play and have your students help in making the puppets and sets. You may also want to involve parents as well. To perform this play for your class, you may want to use a felt board instead.

It may also be helpful to demonstrate how an animal might feel when tangled in litter. This may be used before or after performing the play. (See Extension Activity #1.)

1. Have the students design stick puppets of a turtle, fish, sea bird octopus, seal and lobster from something that could be reused. *(brown bags, styrofoam trays, paper plates, etc.)*

2. Create an underwater scene for the stage.

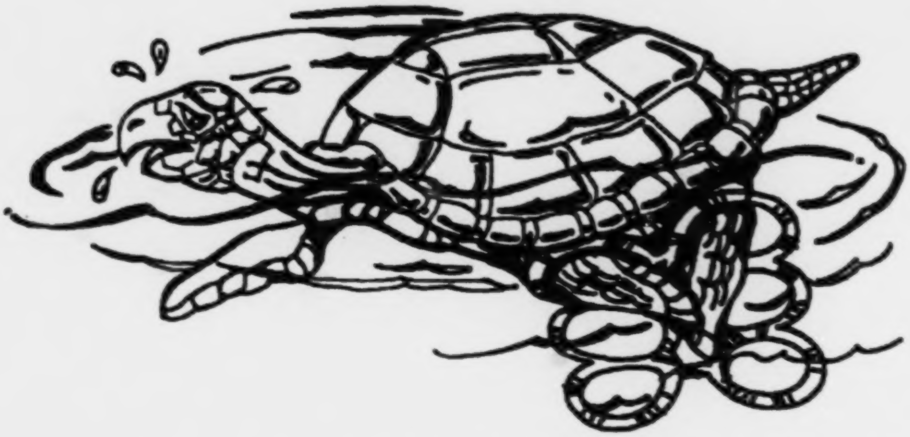
3. Read the story, "The Turtle's Mishap" while students act it out with the puppet characters.

DOWN TO EARTH

The International Coastal Cleanup, the world's largest beach clean-up project, collected 3.7 million pounds of trash along 4,743 miles of beachs in 1991. More than 145,000 people participated in 34 states and 12 countries.

Source: 1993 Earth Journal

The Turtle's Mishap: A Puppet Show



Cast of Characters: Sea Turtle, Fish, Cormorant (sea bird with dark feathers and webbed feet), Octopus, Seal, and Lobster.

As the curtain opens, a sea turtle is swimming around in circles. On one side of his body, make it obvious that his flippers are entangled in a plastic six-pack ring. They are so tangled, they cannot move. His other flippers, though, are free and are paddling back and forth. Because of this, he is only able to swim in a circle.

Turtle: Help! Please, help. My flippers are stuck. *(He continues to struggle and swim in circles. Then along swims a fish and he stops to watch the turtle.)*

Fish: What a strange thing to do. Why are you swimming in circles?

Turtle: Oh, please Mr. Fish, can you help me? My flippers are stuck and I can't get them free.
(Have the fish try to help the turtle by pulling on the plastic ring with his mouth.)
Fish: Oh, you really are stuck! Tell me, how did this happen?

Turtle: I was swimming along and I just didn't see this plastic ring floating in the water. Before I knew what had happened, it was looped around my flipper. I tried to get it off, but then I got my back one stuck too.

Fish: I remember when something like this happened to me. I was poking my head in the rocks on the bottom looking for food, and all of a sudden it was stuck in an old, rusty tin can. It took me quite a while before I was finally able to shake it off. *(Looking behind him and rushing off, he says:)* Woops, I've got to run or I'll be somebody's dinner. Good luck!

(A cormorant, a dark sea bird that swims underwater to catch fish, swims by and is perplexed by the circling turtle.)

Cormorant: You'll never get anywhere going around in circles like that.

Turtle: Maybe you can help. My flippers are stuck in this plastic ring. With your pointed beak, I'll bet you could get a good grip on it.

Cormorant: I'd be happy to try.
(So the cormorant tugs and pulls on the ring, but is unable to free it.)

Cormorant: I'm sorry, I can't budge it! You know, this reminds me of something that happened just last week. I was paddling on the surface when all of a sudden my legs were tangled in some fishing line. As I was trying to get free, it must have caught on something and I was pulled underwater. I could have drowned, but I was lucky enough to get out of that tangled mess just in time. Speaking of that, I need to go catch a breath. I'm sorry I couldn't help.
(The cormorant swims off, leaving the turtle alone. He continues to struggle and swim in a circle. After a time, along swims an octopus.)

Octopus: Is this a new dance or something?

Turtle: No, it's not a dance. I'm going around in circles because my flippers are stuck in this plastic ring. Say, you have a lot of strong legs, could you help me by pulling it off?

Octopus: Let me see what I can do.
(So the octopus tries many different ways to pull the ring off, but his efforts are unsuccessful.)

Octopus: This trash is really a problem. There have been many times I thought I was picking up a clam, only to discover it was the top of a jar or a hunk of glass.
(Along swims a seal.)

Seal: What's going on here? Are you two fighting?

Octopus: No, not at all. I'm trying to pull this plastic ring off Turtle's flippers. Would you care to help?

Seal: I'd be happy to.
(So the two of them tug at the ring, but it doesn't come free.)

Turtle: Ouch! It is so tight, my flippers are really beginning to hurt. Is there something else we can try?

Seal: Once I got caught in an old fishing net. I chewed and chewed until I cut it enough to break free. But this ring is much thicker, I don't think I could chew through it.

Octopus: That gives me an idea. I might know someone who could help.
(The octopus swims off to search for his friend and returns with a lobster.)

Octopus: See, here's the turtle I was telling you about. Do you think you could use your claws and cut through that plastic ring?

Lobster: I'm not sure, but let me try.
(The lobster cuts the plastic ring with his claws and the turtle is free.)

Turtle: Oh, thank you so much. I was beginning to think I would have to swim around in circles for the rest of my life.
(The cormorant and fish return.)

Fish: I just came back to see if you were all right.

Cormorant: I see you got free of the plastic ring. You were lucky this time!

Turtle: I know ... thanks to Lobster. I'll try to be more careful. But sometimes it's impossible to see the trash, especially those plastic rings or bags. Sometimes I wonder if humans think our ocean is just a big garbage can!

Seal: Everybody, listen. What's that noise?
(A faint rumbling sound can be heard and then it gets louder. All of the creatures watch as a motor boat passes overhead. As it goes by, a bunch of trash is thrown overboard and rains down on the animals.)

Turtle (gravely): I just wish they'd stop and think!
(All of the creatures nod in agreement and then the curtain closes)

From: Earth Child - Kathryn Sheehan and Mary Waidner,
Council Oak Books, Tulsa.

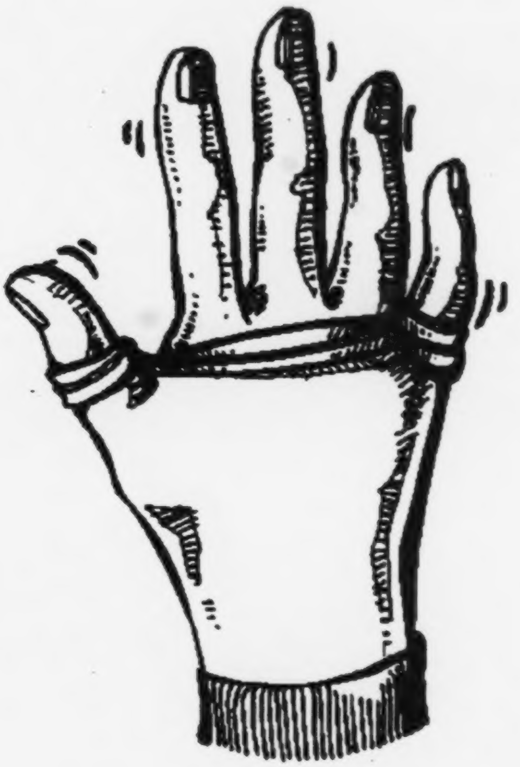
Just Do It

Next time you're at the lake, river or beach, take a trash bag and bring back all of your trash for proper disposal ... and recycling.

Extension Activities

1. *Help! I Can't Get It Off!* That's exactly what animals are thinking when they become entangled in litter, such as a plastic six-pack ring over their heads. They don't have fingers and arms, so they are unable to lift it off. There have even been some reported cases in which baby seals have gotten their heads accidentally through six-pack rings and as they grew the ring tightened and eventually choked them. **Ask:** What is it like to become entangled in debris and unable to free yourself?

This simple hand exercise will help demonstrate this to your class.
Take a rubber band and loop it around your thumb, stretch it over the back of your hand (not the palm, see diagram), then loop it around your little finger. Pretend that your hand is an animal entangled in a piece of litter. Without using your other hand, any other part of your body, or nearby object, try to free yourself from the rubber band. You can move it in any fashion, attempt to use the fingers on the entangled hand, twist it, etc.



As you will soon discover, it is almost impossible to remove. This is the kind of helpless feeling that many entangled animals experience, and what's worse is that the more they struggle, the more entangled they become. This is why it is important to keep our oceans, lakes and rivers free from debris, especially plastics that do not disintegrate and are harmful to the creatures living there.

2. Read the book, *Jack, the Seal and the Sea*, by Gerald Aschenbrenner. English adaptation by Joanne Fink, Silver Burdett, NJ, 1988. In this story, Jack spends his days sailing the sea and taking in nets full of half-dead fish. He ignores the polluted condition of the water until he finds an ailing seal and receives a message from the sea itself about water pollution. He gives up his life as a fisherman to carry the sea's message to mankind so that our oceans can be saved.

Hazards at Home

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: K - 1
Focus: Hazardous products
Subject: Science, Language Arts
Materials: Two puppets; cardboard box approximately 1-1/2 foot square; pictures or containers of hazardous products: oven and drain cleaners, auto cleaners, paint thinner, varnish, used motor oil, gasoline
Teaching Time: 30 minutes
Vocabulary: poison, toxic, hazardous

Learning Objective

Students will:

- recognize that some products are poisonous and harmful to people as well as the environment.

Learning Procedure

1. Introduce the concept of **poisons**. Ask students if they know what it means if something is poisonous, **toxic**, or **hazardous** and if they can name some examples of poisons. (See the Resource Section for more information.)

2. Explain to the students that some things that are used for cleaning, painting, killing unwanted bugs or plants, and maintaining cars can hurt them and other living creatures. Many can be harmful if eaten, inhaled, or touched.

3. Introduce two puppets *(may be animals or people)* and tell the children they have a story to share.

4. Perform the play for the class. *(Option: Ask a class of older students to prepare, rehearse and present to play to the younger students.)*

Question for the Class

What does it mean if a product is poisonous or toxic?

Extension Activities

1. Give students a list of items commonly found around home that may be toxic. Many of them are used to make things cleaner or to make our lives easier. The list might include paint thinner, oven cleaner, bathroom scouring powder, bleach, weed or bug killer, nail polish, turpentine, etc.

Have the students draw a picture of a house and label where these items might be found. Discuss what precautions should be taken with these items. Have the students write a class letter to their parents telling them what they have learned about household hazardous wastes and asking for their help in identifying them at home.

2. Using a pocket folder, paste on one pocket a "Mr. Yuk" or similar sticker, on the other, a "Smiley" face. Have the children cut out dangerous, toxic products and safe products from magazines. Collect and paste these pictures, one of each, on an index card. Turn the index cards over and put either a "Mr. Yuk" sticker for a toxic product, or a "Smiley" face for a safe product. Shuffle the cards together. Each child can choose a card and, looking at the picture, put it in the correct pocket. After all the cards are gone, they can go back and self-check by turning over their picture card.

3. "Mr Yuk" stickers may be obtained at many local poison control centers. If they are not available in your community, have the students make their own versions of the "Mr. Yuk" sticker and take them home to put on hazardous items.

DOWN TO EARTH

It is estimated that the average American household has four or more gallons of paint stashed away in the garage, closet or basement.

The Play

Hazards at Home

Rebecca: Hi Rocky! How are you?

Rocky: Funny you should ask. I had to go to the hospital last week. My stomach still doesn't feel very good.

Rebecca: Too much candy again, Rocky?

Rocky: Not exactly. I was having a good time playing house and ate something I found under the kitchen sink. It looked like something my Mom spreads on crackers at her parties ... It made me very sick and I still have to eat special foods. At the hospital they told me that there are a lot of things in my house which are dangerous to eat, smell, and touch.

Rebecca: Really?

(Rebecca looks in her cupboard — a cardboard box with a door — and pulls out containers or magazine pictures representing various household hazardous substances. For each item she asks the students what it is used for and whether or not it is hazardous. Rephrase the questions by interchanging the words hazardous, poisonous, toxic, harmful, could make you sick, etc)

Rocky: There are a lot of things that are toxic at my house, too.

Rebecca: Well, forget it! If these things can make me sick then I don't want them in my house.

(Rebecca starts to throw the hazardous materials in the trash, but is stopped by Rocky)

Rocky: Don't throw them in the trash, Rebecca! These things are also dangerous there. If they get buried at the dump, rain water can run through them and carry the poisons into our drinking water, or an animal could eat them.

Rebecca: Okay. I'll pour them down the sink instead.

Rocky: Don't do that, Rebecca! If you pour them down the sink they will go to the treatment plant where they try to clean the water. But these poisons can't be cleaned very well so they'll end up in the rivers or lakes.

Rebecca: The river? That could hurt a number of my friends who live there if they were to drink the water. Let's see, there are the Scales, a fish family, and the Quacks--you know that nice family of ducks and their cousins from Canada, the Honkers. *(To the audience)* Do you know anyone who drinks water from the river?

Okay, Rocky, I won't pour them down the drain. But what can I do?

Rocky: Have your parents save these items in a safe place until your town has a hazardous waste collection day. Then your parents can take it where other people will carefully collect the poisonous materials in special containers and take them away to places where they can be thrown away safely. Some can be burned in special ovens. Others, like used motor oil, can be made into new oil.

Rebecca: You mean recycled?

Rocky: You bet!

Rebecca: That sure sounds better than putting these harmful things in the water.

Rocky: It sure is, but do you know the best thing you can do?

Rebecca: What's that?

Rocky: Find other things to use in place of these toxic materials. There are a lot of things you can use to clean with that are not hazardous. I make up a mixture of soapy water to kill the bugs on plants, and use baking soda and water to clean the oven. Then no one has to worry, not the Scales nor the Quacks, not you and not me!

Rebecca: Thanks for telling me what to do about toxins, Rocky. But next time you want to learn something, please ask somebody about it. Don't just eat anything you find around you house. Promise?

Rocky: I promise.

The End

POISONS IN MY HOME?

Dear Parents:

We are studying how to be safe at home. Many common, everyday household products can be dangerous. We are teaching the students how to recognize some of them and to stay away from them, too. Please help by taking a closer look around your house and keeping these products out of childrens' reach. To help our children, here is a list of some household products that can be dangerous that we have talked about in class.

What are Household Hazardous Products?

Household hazardous materials are chemically-based products which can be dangerous to human health and to the environment.

Cleaning Products: ammonia, spray cleaners, window and rug cleaners, furniture and metal polishes, drain cleaners

Garden Supplies: weed and insect killers, fertilizers, gasoline, charcoal lighter fluid

Auto Supplies: antifreeze, motor oil, transmission fluids, cleaners, waxes, gasoline, batteries

Paint Supplies: Furniture refinishers, turpentine, oil-based paints, paint and varnish removers, caulking and sealing products, waxes and glues

Laundry Aids: bleaches, starches, detergents, spot removers

And More: swimming pool chemicals, photographic chemicals, craft and hobby supplies

SPARKLE
GLASS CLEANER
WITH AMMONIA
BUG-
LEMON
Furniture Polish

Action for a cleaner tomorrow.

A South Carolina Environmental Curriculum

For more information about South Carolina and the environment, call the
South Carolina Department of Health and Environmental Control at
1-800-768-7348.

Take It Away!

Preparation Time: **Easy-To-Do** Moderate Extensive

Grade: K - 1
Focus: Garbage
Subject: Music, Language Arts, Social Studies, Science
Materials: Words of the song, *My Garbage Floats Over the Ocean*
Teaching Time: 30 minutes
Vocabulary: Litter, garbage

Learning Objective
Students will:

- understand that there is no place just to take garbage *away*.

Learning Procedure
1. See the Glossary in the Resource section and review the vocabulary for this lesson with students.

2. Sing this song with the class to the tune of *My Bonnie Lies Over The Ocean*. Have students create their own verses.

Questions for the Class
1. In what ways does the garbage come back?

2. What can we do to prevent water pollution?

3. Discuss the need for trash receptacles on beaches, lakes, piers, and boats.

My Garbage Floats Over the Ocean

My Garbage Floats Over the Ocean.
My Garbage Floats Over the Sea.
My Garbage Floats Over the Ocean,
My Garbage Comes Back to Me.
Come Back, Come Back,
Come Back My Garbage to Me … to Me.

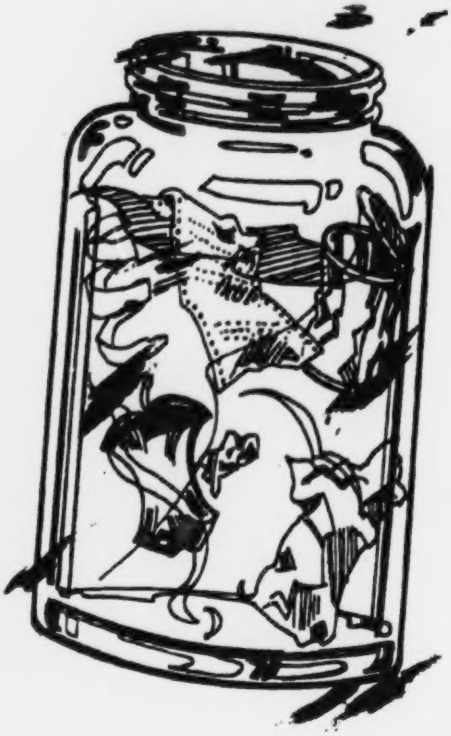
DOWN TO EARTH

Only 45 years ago. Americans could see twice as far on a summer day on the East Coast as we can see today.

Extension Activity
Share with the class the **Litter In A Lake** experiment.

1. Use a large, clear glass or plastic jar (such as a sun tea jar or a large gallon-sized pickle jar) to represent your lake. Fill the glass jar with water and add litter to the lake. Use items such as small pieces of fruit peelings, gum wrappers, plastic wrap, lid from a tin can, scrap paper. You may collect these items from the cafeteria.

2. Let the lake stand undisturbed. Observe every day for about two weeks. **Ask:** What happened to the water? What happened to the litter? Would you want to swim in water like this? What do you think happens to the plants and animals that live in water with pollution? Is the ocean big enough to take all our garbage?



Where Trash Goes

Preparation Time: **Easy-To-Do** Moderate Extensive

Grade: K-1
Focus: Landfills
Subject: Social Studies, Science
Materials: Materials for overhead (included)
Teaching Time: One class period
Vocabulary: Sanitary landfill, transfer, waste, trash, garbage, greenboxes, composting

Learning Objective

Students will:

- understand how household and school trash goes to the landfill.

Background

South Carolina has about 39 municipal solid waste landfills, of these, only eight have been permitted and meet new federal standards. These municipal landfills are where your school and household **garbage** are taken for disposal. (In some areas of the Low Country, garbage is incinerated.)

In many cities and towns in South Carolina, household garbage is collected on-site – using special containers (sometimes called "herbie curbies") that each family fills that are picked up and emptied into garbage trucks.

Many rural communities have off-site collection. This means that families are responsible for taking their garbage to special collection areas where large containers, often called **greenboxes,** are located. Many counties are replacing their greenbox collection containers with special collection stations that have workers in charge. These workers make sure that only household garbage is disposed of in the containers. These stations also have special containers to collect items for recycling and to collect yard waste such as grass clippings, branches and leaves that do not belong in the landfill. This yard waste goes to a special **composting** facility where it decomposes and produces a rich mulch that is used in gardening.

In many parts of the state, **waste** collected from homes, collection stations and greenboxes is compacted – smashed to make it smaller. This helps reduce the amount of space the waste takes up in the landfill.

Today's modern **sanitary landfills** must meet strict state and federal requirements. A landfill is very different from the dumps of the past. Sanitary landfills protect the surrounding land and water, and are lined so that all the waste stays in the landfill and does not pollute nearby land and water. Dumps were just big holes dug for burying trash.

Learning Procedure

Use the overhead, *Where Trash Goes*, to review the route household/school wastes take to the landfill. (Option: Collect a bag of clean trash and then use the overhead.)

Questions for the Class

1. Why is it necessary to take our trash to a special place? Why not just leave it in the backyard or by the side of the road?

2. How is a sanitary landfill different from a dump?

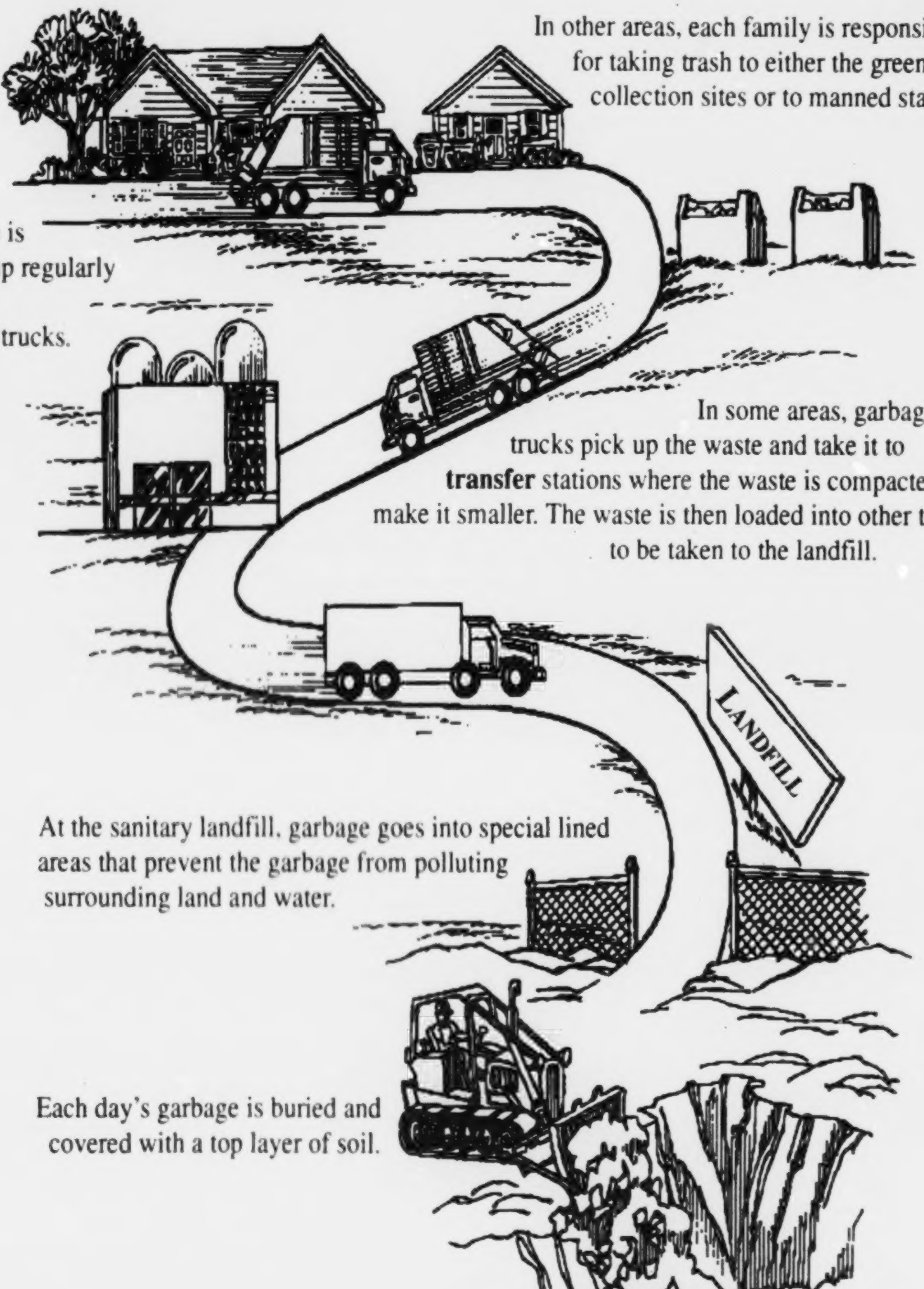
DOWN TO EARTH

There are about 7,300 pieces of human-made garbage in space. When a rocket is sent to space, not all of it comes back. Stages drop off and other pieces of high-tech flotsam and jetsam end up being left in space ... most of it less than four inches square.

Source: *P3*, The earth-based magazine for kids

Where Trash Goes

An average family throws away about 200 pounds of garbage each week.
In many areas, each household has a "herbie curbie" trash container to put **trash** in for collection by garbage trucks that come by on a regular schedule.



In other areas, each family is responsible for taking trash to either the greenbox collection sites or to manned stations.

Garbage is picked up regularly by large garbage trucks.

In some areas, garbage trucks pick up the waste and take it to **transfer** stations where the waste is compacted to make it smaller. The waste is then loaded into other trucks to be taken to the landfill.

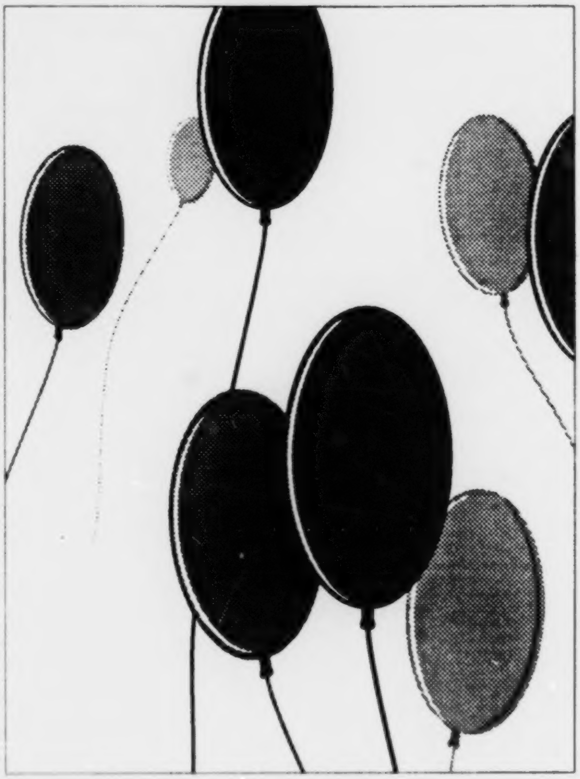
At the sanitary landfill, garbage goes into special lined areas that prevent the garbage from polluting surrounding land and water.

Each day's garbage is buried and covered with a top layer of soil.

Clean or Dirty?

Preparation Time: Easy-To-Do [✓ **Moderate**] Extensive

Grade: K-1
Focus: Pollution of natural resources
Subject: Science, Health
Materials: Balloons, paper for folding fans, glass of water, potted plant
Teaching Time: One class period
Vocabulary: Air, water, soil, pollution



Learning Objective
Students will:

- see the importance of clean air, water and land
- understand what pollution is and the many forms of pollution.

Learning Procedure
For more information on pollution of natural resources, see the Resource section.

1. Ask a volunteer to blow up the balloon. (Note: balloons can be dangerous. Please supervise your students while they are handling the balloons.) Then let the air out slowly so that children can feel it with their hands. Explain to students that the **air** rushing by is what they feel.

Ask: Why do we need air? Have students take a deep breath to demonstrate that we all need clean air, without it we cannot live. Have students make a fan out of folded paper to move air so that they can feel it. Discuss examples of the air moving such as the wind, whistles, paper airplanes.

2. Hold up the **water** in the glass. **Ask:** Why do we need water? Have students relate their experiences with water. Make a list on the board of all the ways we use water.

3. Hold up the potted plant. **Ask:** What grows in the **soil**? Does anyone have a garden? What do you grow? If we had no soil, could we grow food? Discuss why soil is necessary.

4. **Ask:** What is **pollution**? Have you ever seen pollution? Where was it? What did it look like? How does the waste we produce pollute our air, water and land? Why is pollution bad for us?

Action for a cleaner tomorrow.

A South Carolina Environmental Curriculum

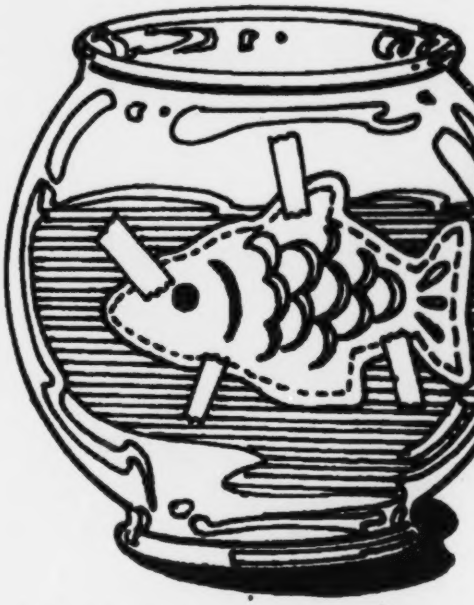
For more information about South Carolina and the environment, call the
South Carolina Department of Health and Environmental Control at
1-800-768-7348.

K.III.4.F

Life In A Fish Bowl

Preparation Time: Easy-to-do Moderate **Extensive**

Grade: K-1
Focus: The effect of pollution on wildlife
Subject: Science, Language Arts
Materials: Glass fish bowl or similar container, fish made from plastic meat tray, overhead projector or flashlight (optional but recommended), 8 empty film canisters with tops (or 1/4 cup of each ingredient) one each containing soil, sand, liquid dish detergent, chocolate syrup, salt, paper (confetti), powdered detergent/hot water, red food coloring
Teaching Time: One class period
Vocabulary: Eroding, fertilizer, decompose, pollution



Learning Objective

Students will:

- understand the effect of water quality on living things.

Note: This lesson represents what water quality could be like without the strict monitoring and regulations now in place or the care of concerned citizens. Today, South Carolina has very good water quality. The point of the lesson is that we must continue to protect our water quality.

Learning Procedure

1. For this lesson, you will demonstrate what can happen to a fish in a river when people pollute the river. To demonstrate this, you create a friendly fish character and a river to bring the story to life, have your students name your fish and the river.

2. Your fish-bowl river can be made from a glass or plastic fish bowl; pickle jar; three-liter, clear soft drink bottle (remove plastic boot from bottom and cut off the tapered top); or any similar container. Your fish can be cut from a reused, clean meat tray or any other water-proof item.

3. Put the fish on a stick or tape it to the front of your bowl. To see the effects of pollution on your "river," put the bowl on an illuminated overhead projector or use a flashlight behind the your "river." Remove a cup full of clear water to demonstrate to the students the clean water in the beginning and the dirty in the end.

4. Read and adapt the narrative. Ask individual students to add the ingredients in the film canisters as indicated to represent pollution.

Note: Teachers should review the narrative in advance and adapt the language to the students' level. Also look for ways to personalize the story

Water use in South Carolina amounts to 1,916 gallons per person per day.

Source: 1994 Environmental Almanac

by including the name of your fish and the name of the river.

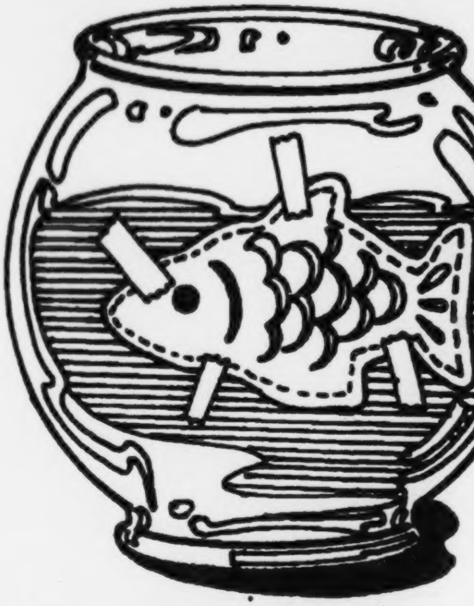
NARRATIVE: Imagine a river as it meanders through the countryside, past the farmers' fields, widening into a lake, but narrowing again as it passes through the city. In this river, named __________ lives a fish. Its name is __________. *(Point to the fish in the clear water in the fishbowl.)* **ASK: HOW DOES IT FEEL TO BE THIS FISH?** *(This question should be asked repeatedly throughout the story and should generate an enthusiastic response from your students. Let students respond aloud.)*

The fish swims down river past an **eroding** bank. An eroding bank is where soil sometimes washes into the river. When it rains, what will happen to the bank? What if it rains a great deal? *(Have student pour soil from the container into the water.)* **ASK: HOW DOES IT FEEL TO BE THIS FISH?**

Suppose part of the soil eroding into the water came from farmland. The farmer has just put fertilizer on the field. Instead of staying on the field to help the crops grow, some of the **fertilizer** may ride "piggy-back" on the eroding soil and go into the river. *(Add sand to simulate fertilizer.)* What effect will the fertilizer have on the plants in the river? *(It will make plants grow.)* If the plants grow too abundantly and too fast, the river can't continue to support them. They die, fall to the bottom, and start to **decompose**.

Decomposing things use oxygen. What else in the river needs oxygen? *(The fish.)* **ASK: HOW DOES IT FEEL TO BE THIS FISH?**

Farm fields aren't the only source of fertilizer that can flow into a river. Homes may also be a source. Where the river has widened into a lake, several families have built their homes. Perhaps their septic tanks drain into the water or some of the fertilizers they've put on their lawn have washed into the water. *(Add liquid dish detergent to represent **pollution** from homes.)*



As the lake narrows back into a river, our fish continues downstream past the city. Even though the city people don't pollute the water directly, what they do at their own homes or subdivisions can affect the quality of the river's water. Have you ever seen a car leaking oil? Where does the rain wash this oil? *(Put chocolate syrup, representing oil, into the fish bowl.)* **ASK: HOW DOES IT FEEL TO BE THIS FISH?**

In the winter, when it gets icy and snows, what do we put on our roads to make it easier to drive? *(Salt or sand. Put salt into the water.)* When you eat or drink something salty, what do you do? *(You get something else to drink.)* Can this fish get fresh water to drink? *(No.)* **ASK: HOW DOES IT FEEL TO BE THIS FISH?**

Suppose the city has a park next to the river. People litter the park and some of it blows into the water. *(Put pieces of paper into the fish bowl.)* **ASK: HOW DOES IT FEEL TO BE THIS FISH?**

As the river leaves the city, there are several factories that are located along it. Although regulations are strict, if the factory's control equipment is not working properly, some chemicals or heated water may flow into the river. *(Put powdered detergent and hot water into the fish bowl and stir for effect.)*

ASK: HOW DOES IT FEEL TO BE THIS FISH?

The waste water treatment plant for the city is also located along this section of the river. The plant does its best to clean out impurities, but some polluted water gets into the river. The river has a large volume of water though, and the plant only puts a small amount of pollution into it. It shouldn't cause too much of a problem. Right? It would be like putting two drops of this food coloring into this jar of water. *(Put in food coloring and stir it.)* **ASK: HOW DOES IT FEEL TO BE THIS FISH?** *Hold up the cup of clear water you set aside at the very beginning and* **ASK: WHERE DO YOU THINK OUR FISH WOULD RATHER LIVE?**

Questions for the Class

1. Have you ever seen a river, lake, or beach closed for swimming?

2. Would you want to swim in a river like the one in our story?

3. Go back through the story, deciding ways that YOU can help solve some of these problems. *(For example, prevent litter in the park, repair car with leaking oil, etc.)*

Extension Activity

(Read or improvise as a blues tune.)

THE DIRTY WATER BLUES
Pure water gurgles
and splashes along
until pollution
flows into the song:
oil,
tar,
paint,
dye,
mud and muck
come splashing by.
Cans,
jars,
bottles, cars.
Old shoes, old news--
that's the dirty water blues.
Sweet fresh water
rolls away from this song,
while dirt and pollution
keep flowing along
and along,
and along...

Source: Save The Earth! An Ecology Handbook for Kids

Just Do It

Use water wisely at home. And always take a trash bag with you when you go to the beach, lake, or river. Pick up your own trash and leave the shore line cleaner than you found it.

Action for a cleaner tomorrow.

A South Carolina Environmental Curriculum

For more information about South Carolina and the environment, call the
South Carolina Department of Health and Environmental Control at
1-800-768-7348.

What's A Cycle?

Preparation Time: **Easy-To-Do** Moderate Extensive

Grade: K - 1
Focus: Recycling
Subject: Science, Language Arts
Materials: *What's A Cycle* worksheets included
Teaching Time: One class period
Vocabulary: Cycle, recycle, solid waste, compost

Learning Objective

Students will:

- apply their knowledge of cycles to understanding the process of recycling.

Background

A **cycle** is a series of events that continues forever. **Recycling** imitates nature's cycles by giving new life to materials that might otherwise be disposed of as trash. Recycling means to break items down, reprocess them and return them to a new use. Many things that are thrown away can be recycled.

Recycling benefits all of us by reducing the amount of garbage or **solid waste**, conserving energy and resources, creating jobs and reducing pollution.

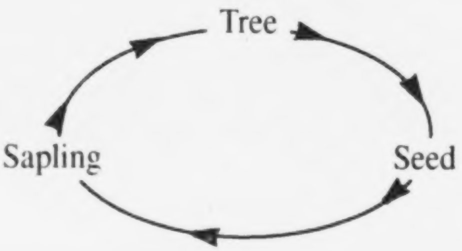
The symbol for recycling is a series of arrows that forms a continuous loop. This loop represents the cycle that takes place when materials are recycled.

Some wastes such as food and yard trash can be composted, that is, allowed to decompose and turn into mulch or humus that can enrich the soil. **Composting** is a natural form of recycling. Composting breaks down yard wastes, reprocesses these wastes into mulch, and the mulch is returned to the soil.

Learning Procedure

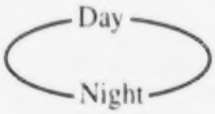
1. Write the word "cycle" on the board. Ask students what they think the term means. Develop a definition on the board.

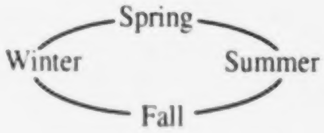
2. Explain to students that cycles are a part of life. A cycle is a series of events that can last forever. A cycle may go through changes, yet change eventually arrives back to where the cycle began. Share with the class the cycle of a tree.



A tree grows from a seed, produces new seeds which, in turn, produce new trees. Cycles ensure that life can go through many changes, yet maintain its stability. The new tree is patterned after the old.

3. Explain to students that there are many cycles around us. Ask students if they can think of any cycles. (*Days of the week or months of the year*) Write the following cycles on the board and ask students to discuss:





Each year Americans use more than 230 million trees' worth of wood products.

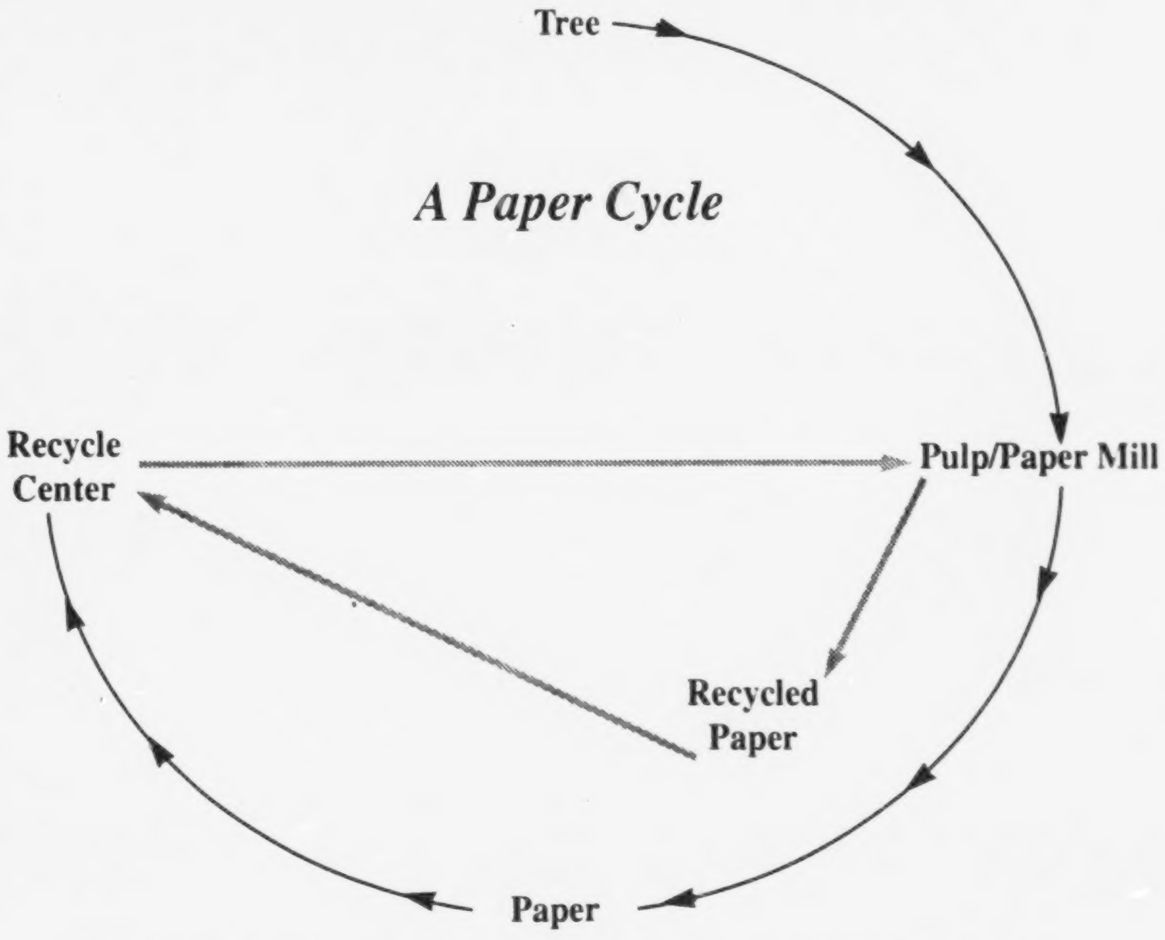
4. Explain that cycles are also important to our everyday lives. Divide the class into small groups of three to five students and ask them to discuss and draw a cycle of their typical school day. Discuss what would happen if every day were completely different, that is without repeating a pattern. *(You wouldn't build on the past, wouldn't know what to expect.)*

5. Write the word "**recycle**" on the board. Ask students what they think the term means. *(To make into something to use again.)* Develop a definition on the board. Explain that many cycles depend on people to make them happen. To recycle something means to give the object a new beginning by changing it into something that can be used again.

6. Share the activity sheets, *What's a Cycle*, with the class. You may use as handouts or laminate them to be used over and over again.

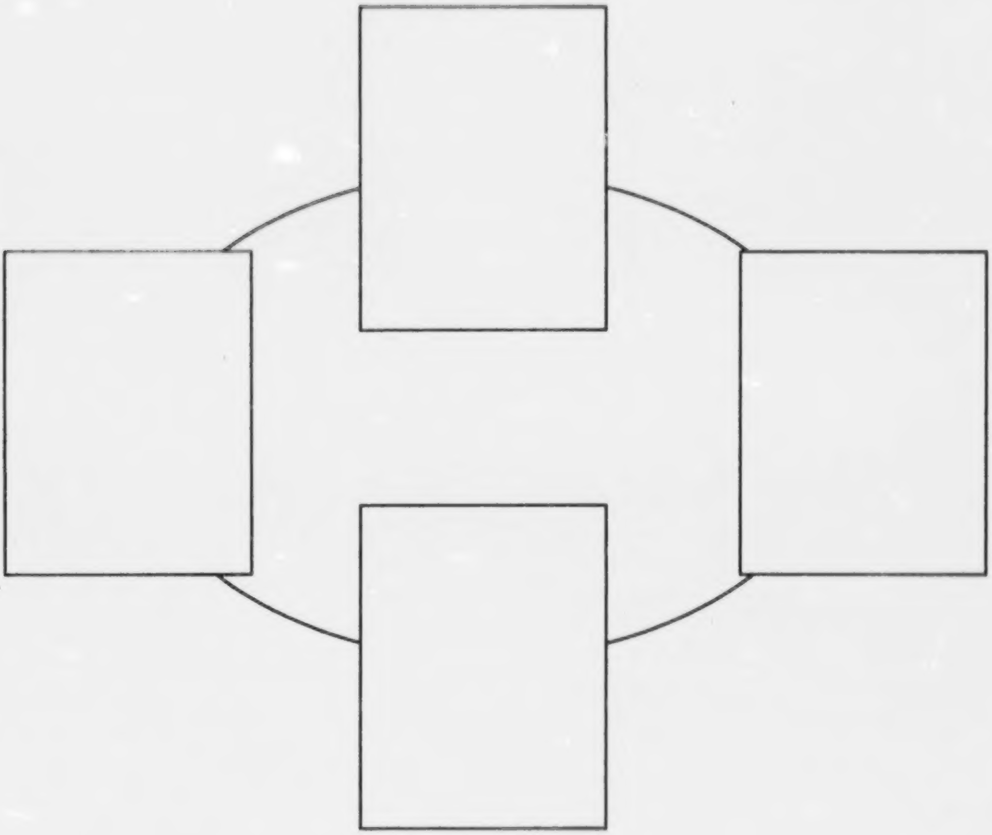
Just Do It

Make recycling a part of
your daily cycle!


A Paper Cycle

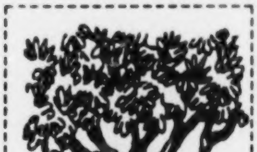
Explain that paper cannot be planted to make a new tree, but it can be recycled to make new paper and paper products. While this is not a true cycle of nature, it is a human-made cycle that 1) restores new life to useful objects, 2) conserves our resources (trees, energy), and 3) reduces pollution caused by discarding old items and manufacturing new items.

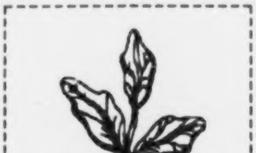
What's A (Tree) Cycle?

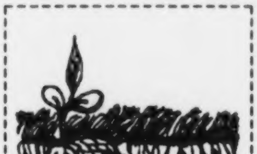


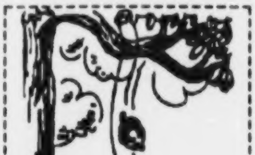
Name________________________________

Cut, color and paste the pictures into the correct order to show the cycle of a tree.

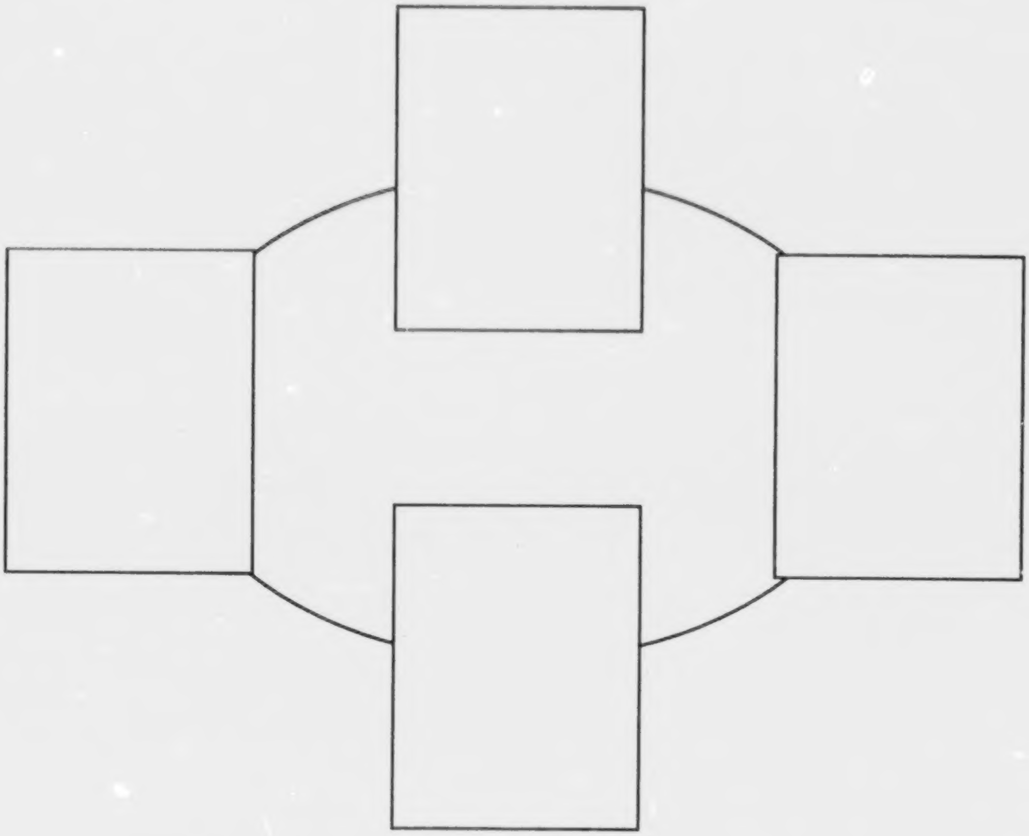






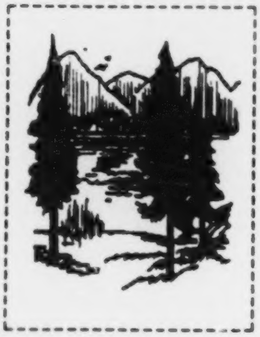


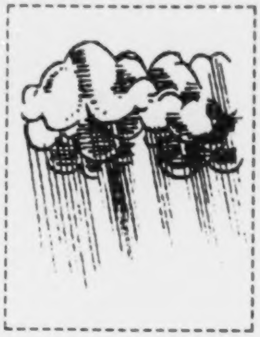
What's A (Water) Cycle?

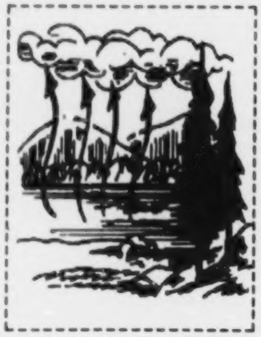


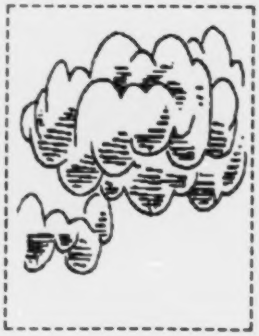
Name________________________________

Cut, color and paste the pictures into the correct order to show the cycle of water.









Recycle It!

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: K-1
Focus: Recycling
Subject: Social Studies
Materials: *Recycle Cycle* transparency, *Recycled Items* handout, Recycle symbol, various items with recycle symbol, drawing paper, crayons or markers, samples of products with recycling symbols
Teaching Time: One to two class periods
Vocabulary: Recycle, recyclable, recycled, precycle

Recycle It!

Learning Objective

Students will:

- recognize the recycled symbol and understand that it indicates that a product is made from recycled materials
- recognize the recyclable symbol and understand that it means that the item can be recycled in some areas
- understand recycling as a *loop* process
- identify items that can be recycled.

Learning Procedure

1. **Ask**: What does **recycle** mean? *(Recycle means to take something that isn't going to be used for its original purpose and make it into something new.)* Hold up an item that has a recycle symbol on it. Draw the symbol on the board. *(See symbol with this lesson.)* Explain that the symbol is made of three arrows in the shape of a triangle. Demonstrate that, if you start at one arrow and follow it, you go around and around in a *loop*.

Explain that this *loop* represents how recycling works. For example, an item that needs to be disposed of is taken to a recycling center instead of put into the trash. The item – along with many other similar items – is shipped to a recycling plant, or materials recovery facility, that reprocesses the material into a new item. The new product goes to the store, where it is purchased. Go through this process with several items, such as a plastic soda bottle or aluminum can. (See Recycle Cycle transparency.)

2. Pass around samples of products with recycling symbols. Explain to students that there are several versions of the recycle symbol. Ask students if they know the difference between **recycled** and **recyclable**. *("Recycled" means the item was made from recycled material. "Recyclable" means that the item was made form material that may be recyclable in your area.)*

3. Discuss the importance of looking for the symbol when you shop. Explain that many people **precycle**. Precycling means that they buy products that can be recycled or reused and that they buy products made from recycled materials whenever they can.

4. Ask students if they have items at home that can be recycled. List on the board recyclable items the students can name.

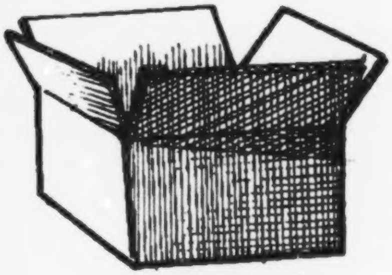
5. Distribute *Recyclable Items* handout and review.

6. Using drawing paper and crayons or markers, have students draw several items that are recyclable that can be found in their home.

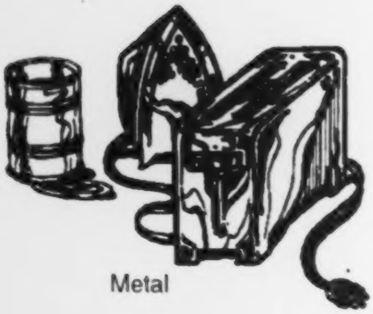
Extension Activity

Have students bring in items that display a recycle symbol and show which items are recyclable and which are made from recycled materials.

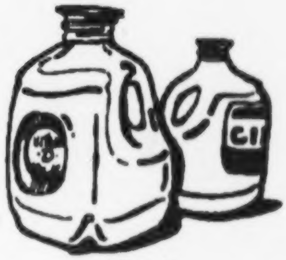
Recyclable Items



Cardboard and paperboard

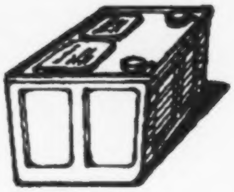


Metal

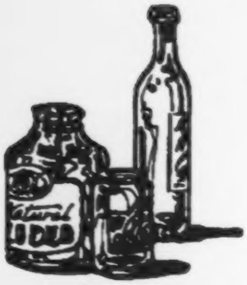


Plastic

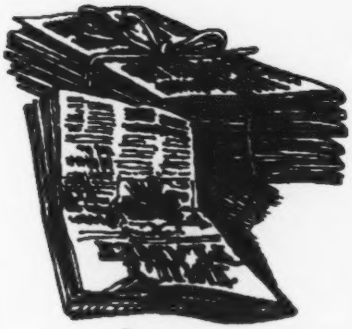
Tires



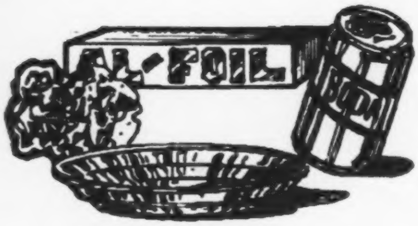
Car Batteries



Glass



Paper

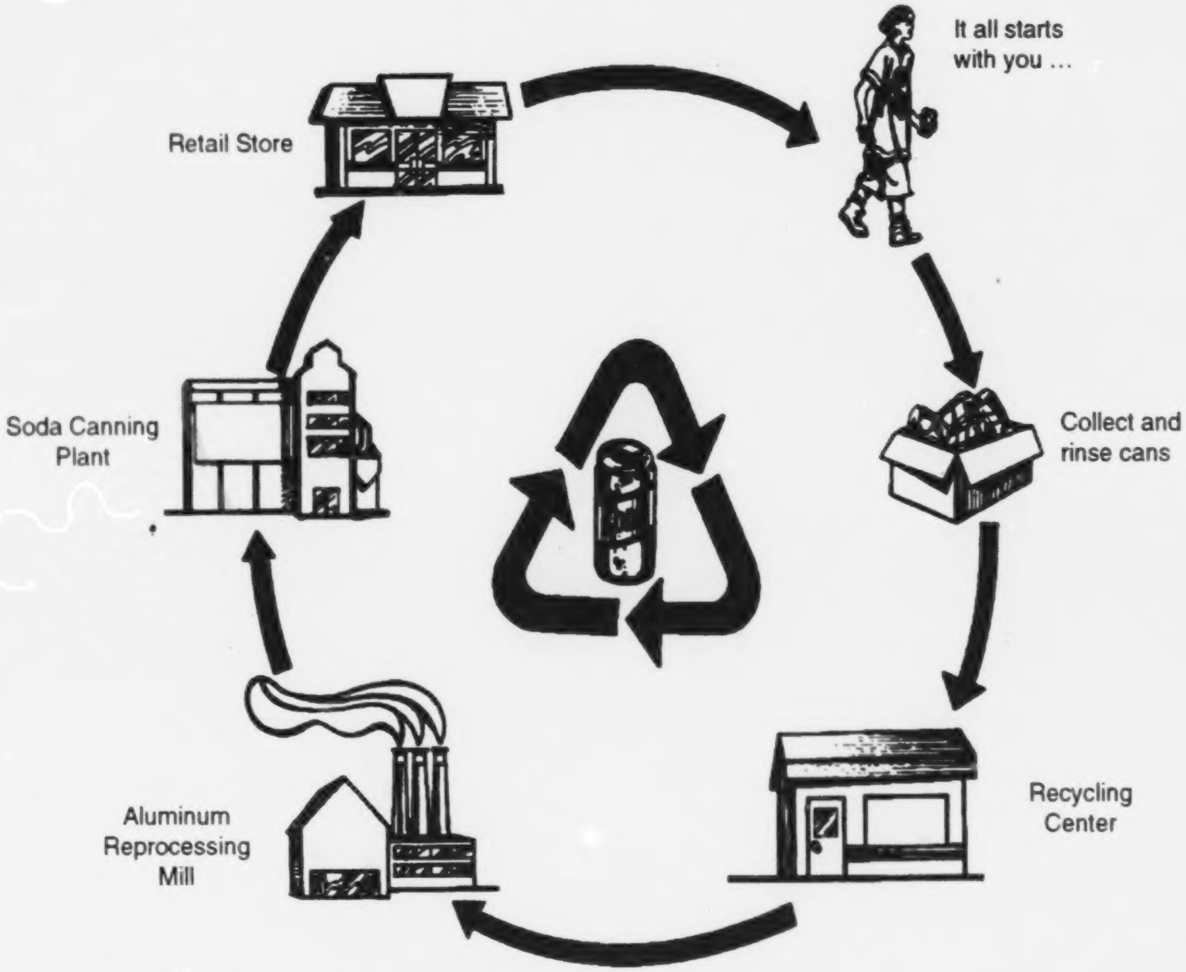


Aluminum

Not everything is
recyclable in every
community. Look
in the phone book
for the number of
your county waste
manager to see
what can be
recycled in
your town!

Used Motor Oil

Recycle Cycle


It all starts with you ...
Retail Store
Collect and rinse cans
Soda Canning Plant
Recycling Center
Aluminum Reprocessing Mill

It all starts with You!

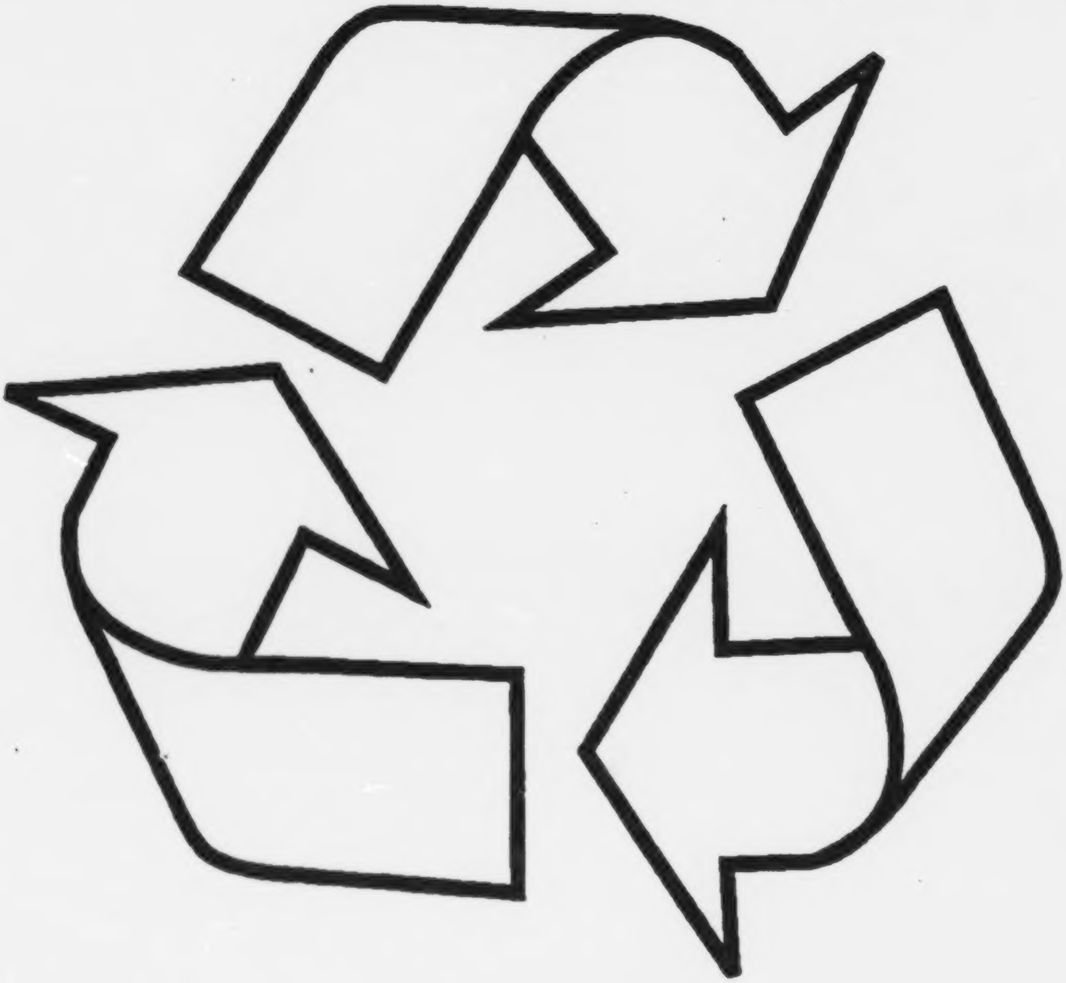
Enjoy the product...

Rinse it and place empty can in recycle bin...

See that items are taken to Recycling Center...

The aluminum mill reprocesses the material into useful aluminum that is made into cans or other aluminum items...

Reprocessed cans go to the soda pop canning plant where they are filled again...



Recycle

What's Recyclable?

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: K - 1
Focus: Recycling
Subject: Social Studies, Science
Materials: Items that are recyclable in your area, old magazines
Teaching Time: Two class periods, ongoing
Vocabulary: Aluminum, plastic, glass, paper

Note: For this activity, concentrate on items that are recyclable in your area. Stress that as recycling becomes more available, more items will be recycled.

Learning Objective

Students will:

- identify recyclable materials and learn how to prepare these materials for recycling.

Background

Some materials are easier to recycle than others. Many objects, while recyclable, may not be collected in your area. It is important to know what materials can be recycled locally and how to prepare them for recycling.

The most common recyclable materials are clear glass, certain types of plastic, newspaper, and aluminum. Some communities also recycle steel (tinned) cans, cardboard, magazines, many types of plastic, and brown and green glass. As recycling grows, more and more items will be recyclable.

The method of collecting recyclables also varies from community to community within South Carolina. For example, some areas have recycling bins that are distributed to each household. These bins are used to collect a family's recyclables for a certain period of time, such as one week, and then are picked up by special recycling trucks. In other areas, central recycling collection centers receive recyclables that families collect and then bring to the center. In some areas, collection centers pay for recyclables. (For more information on recycling in South Carolina, see the Resource section.)

Learning Procedure

1. **Ask:** What's recyclable in our area? Discuss this with the class and explain the recycling options available. **Ask:** Do you recycle at home? What items? Where do they go?

2. Show examples of recyclable objects.

3. **Ask:** How do you prepare recyclables for collection? *(Again emphasize methods in your area. Should aluminum cans be crushed? Should newspaper be bundled with string or placed in paper bags? Should milk and water jugs be crushed?)* Also discuss methods to keep recyclables from becoming unsightly. *(Always rinse and dry containers to prevent attracting pests, etc.)*

4. Ask each student to select a picture of an object that is recyclable from an old magazine. Each child will explain to the class why the object is recyclable and how to prepare the item for recycling. Have the class make a large poster-size collage of all the items and keep the poster on display.

Extension Activities

1. Have students make a "How to Recycle" book to take home.
2. Share the *Save, Sort, Recycle* activity with the class. You may want to laminate for permanent use.

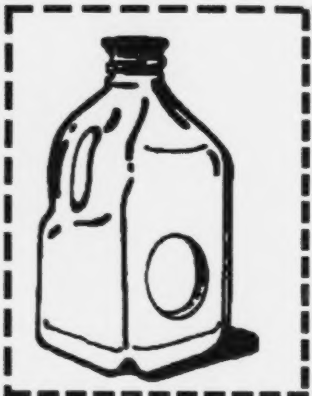
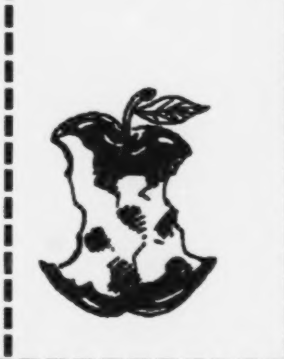
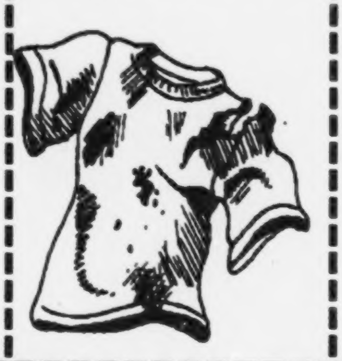
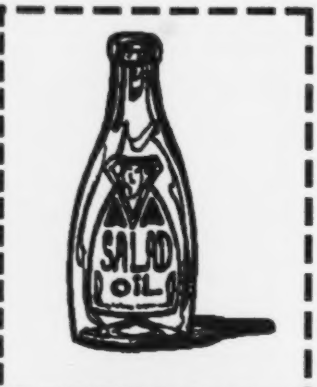
DOWN TO EARTH

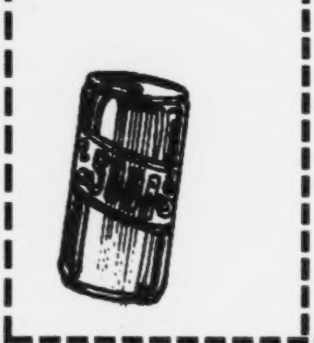
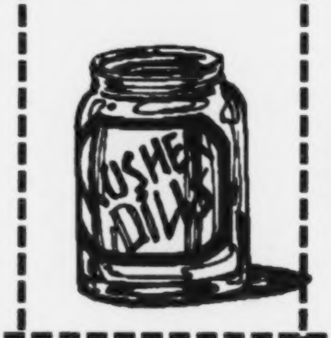
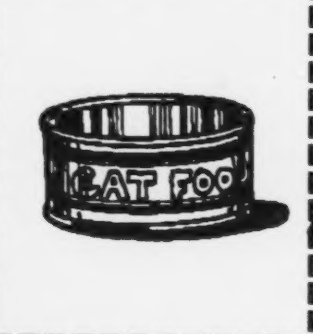
There are about 600 paper and paperboard mills in the United States. About 200 of these mills depend exclusively on recovered paper as their raw material.

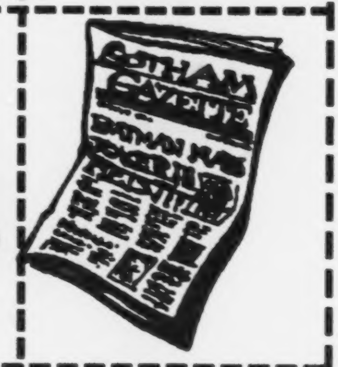
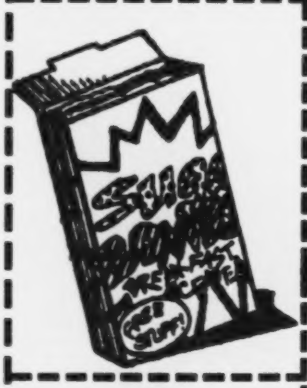
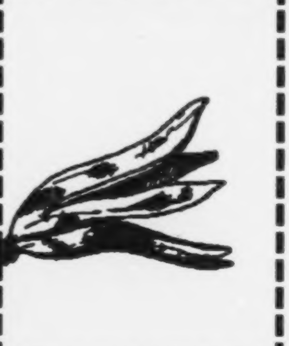
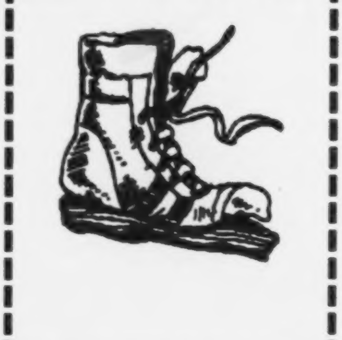
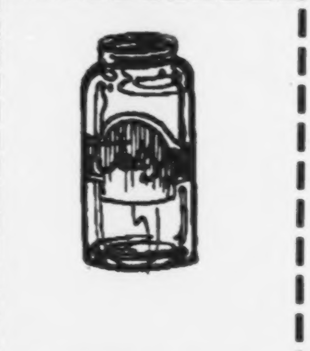
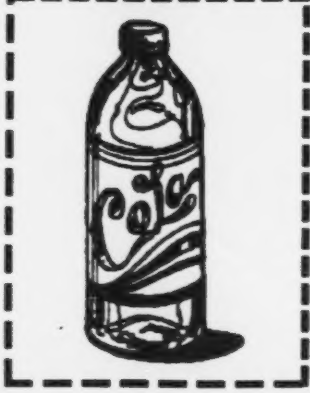
Source: American Paper Institute

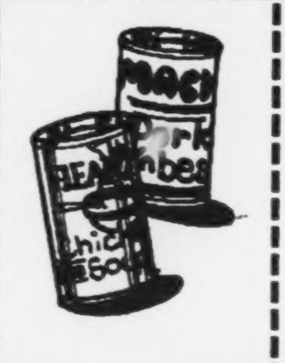
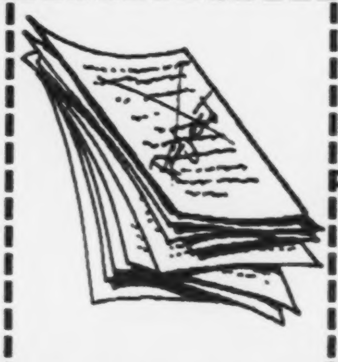
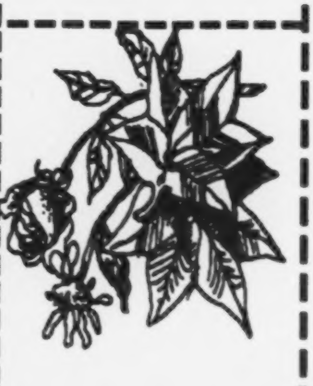
Save! Sort! Recycle!

Color the recyclable items on this page. Then cut them out and paste them into the proper recycling bins on the other page. (Option: Have students divide real items shown on the handout into appropriately labeled boxes.)



KOSHER
DILLS



GOTHAM
GAZETTE

BREAKFAST CEREAL
FREE STUFF!






Pork n beans
Chicken soup



Save! Sort! Recycle!

Compost

Plastic

Aluminum

Second Hand Shop

Paper

Glass

Action for a cleaner tomorrow.

A South Carolina Environmental Curriculum

For more information about South Carolina and the environment, call the
South Carolina Department of Health and Environmental Control at
1-800-768-7348.

Giving Trees A Second Chance

Preparation Time: Easy-To-Do Moderate **Extensive**

Grade: K - 1
Focus: How paper is made, saving resources
Subject: Science, Social Studies, Performing Arts
Materials: Transparency on *Making Paper*, recycled paper items, also puppet/play materials listed with *Giving Trees A Second Chance*, *The Paper Cycle* transparency, *Making Paper* worksheet
Teaching Time: One or two class periods
Vocabulary: Pulp, vat, recycle

Learning Objectives

Students will:

- identify the sequence of making paper
- understand that one step in paper making can be eliminated when we recycle.

Learning Procedure

For more information on paper recycling, see the Resource section.

1. Using the *Making Paper: From the Forest to the Classroom* transparency, describe the process of making paper.

2. Bring to class or have students bring to class items made from recycled paper. Discuss how recycling saves trees.

3. Perform the play *Giving Trees A Second Chance*. In this play, characters show that recycling is one way to keep from wasting natural resources. From the play, students will see how both trees and recycled paper can be used to manufacture paper and other products. You may have students prepare the stage, props, and puppets in advance as a classroom art project. You may perform the play for students or invite two parents to act out the parts or you may work with a class of older students to prepare and perform the play.

Materials for puppet play

Animal puppet, human puppet, small tub about 2' x 1' x 1' - labeled "paper factory," bowl, egg beater, paper, crayons, examples of non-recyclable paper items *(envelopes with plastic windows, wax paper, foil-coated paper)*, examples of items made with recycled paper *(cardboard egg cartons, ticket stubs, toilet paper rolls, etc.)*, cardboard tree, saw, rolling pin, small pitcher.

It take approximately 45 minutes to perform this play.

- Explain to the class that new paper products are generally made from trees, but that in some cases paper manufacturers can use recycled paper instead of new wood to produce paper items.

Although trees will continue to be cut down, the number of trees that are cut can be reduced if people recycle.

- Set up stage along with the cardboard tree.

- Introduce puppet characters, *Rebecca Rabbit* (or any other puppet you make) and the *Logger*. Tell students they have a story to share.

DOWN TO EARTH

In December 1991, Brazilian President Fernando Collor de Mello set aside 19,000 square miles of virgin rainforest — an area the size of Switzerland — as a homeland for 500 Kaiapo natives.

Source: 1993 Earth Journal

Giving Trees A Second Chance

Rebecca: Hi! My name is Rebecca Rabbit. I live here in the forest. Well, it's my nap time, good night.

(Rabbit lies down under cardboard tree. Human puppet with saw enters and starts to cut down the tree. Make saw noises.)

Rebecca: Hey! Hey! What are you doing?

Logger: I've got to cut down this tree so we can have newspapers. *(Turns to students.)* does anyone here have newspapers at their house? *(Turns to Rabbit)* To put out the paper every day, I have to cut down trees and haul them away.

Rebecca: But you can't do that! A lot of animals need this tree! I use its leaves in my burrow to make it warm. *(Turns to students)* Do you know any other animals that might use this tree?

(Add to student responses as needed. Examples include: birds, bugs and squirrels live in them; beavers build their homes from them and eat the bark; many animals eat their fruit; animals use them to escape from predators, etc.)

Rebecca: (Turns to Logger) See all the things we need this tree for? How can you take it?!

Logger: People want to read the newspaper every day, as well as books and magazines, so I cut down trees and haul them away. *(Logger drags tree off desk)*

Rebecca: I'm going to follow him. I want to see where he's taking my tree! *(Put tub labeled "paper factory" down on desk)* I think he brought it here. *(Rebecca sticks her head into tub and comes out again)* Yes — here it is. *(Turns to students)* Can you see inside the factory? *(Students say NO)* Okay, I'll go inside and then tell you what is going on.

(Rebecca goes into tub, which rattles and makes factory noises, then comes out.)

Rebecca: It sure is loud in there! *(Goes back in and comes out.)*

Now I can tell you how they make paper. First, they chop the tree into tiny pieces and put it in a huge bowl like this — *(pretends to put sawdust into bowl)* — except that their bowl is big *(or mention some other object that is about 8-foot square)* Next, they pour water into it and stir it up just like this. *(Rebecca pretends to pour in water from the pitcher and then uses eggbeater vigorously.)*

Boy, am I tired! This takes a lot of energy! *(Continues to use eggbeater.)* I'm working hard. I'm using up a lot of my energy ... Whew! Guess what it looks like now? It looks like hot cereal — oatmeal!

Now, is the paper you write on wet or dry? Dry? Well, the way they get the water out of the paper mixture is with many huge rolling pins. I'm not kidding! They're as long as this room. Guess how many? Over one hundred huge rolling pins? *(Put bowl on floor and demonstrate rolling pin on table.)*

When it's done, the paper looks like this! *(Hold up a piece of paper.)* I think I'll draw a picture. *(Rebecca scribbles)* I don't like this one, I think I'll throw it away. *(Heads for trash can.)* Wait a minute. I can't throw this away! This was my tree. It took all that hard work to make this paper. What can I do?

(If children mention recycling, ask them what that means. If they don't, Rebecca can ask them if they've ever heard the word recycling. Students may also mention ways to reuse the paper.)

Rebecca: Recycling means the used paper goes back to the factory and is made into new paper. I think I'll go back to the factory and see how it is done. *(Rebecca sticks her head under the tub and pulls it out again)* It's almost the same as making new paper, but we don't have to cut down as many trees. We use the old paper instead. *(Rebecca shreds the paper into the bowl and uses the eggbeater on it, then pulls out another piece of paper, as good as new.)*

Rebecca: The people at the factory told me to tell you to make sure you don't recycle Kleenex. And gum wrappers cannot be recycled because they clog up the beaters. No plastic or wax paper either, okay? These things get caught in the drain and could ruin the new paper.

Can you guess what else is made out of old paper? *(Pull out and label whatever examples you have.)* Pretty neat, huh? Do you kids have a box in your classroom to collect used paper that can be sent back to be recycled? That's great, you're saving trees from being cut down. *(OR, We'll have to get you one so you can save trees from being cut down.)* Just remember, no food or tissues in there.

Do you have any questions for me before I go? You know what? After today, I think I'm going to change my name. I think I'm going to call myself RECYCLING RABBIT! Well, it's time to go. Bye!

(The children may want some personal contact with Rebecca after the show, so you may want to have her shake the hands of the students before she leaves.)

Extension Activities

1. Review with students *The Paper Cycle* using the handout/transparency included.

2. Have students make recycled paper. See How To Make Paper instructions in the Resource section.

3. Distribute the attached handout, *Making Paper*. Have students color the pieces and assemble them in their proper order. Make an enlargement of the pieces to post on the bulletin board. To save paper, you may choose to laminate a copy of the handout for students to enjoy again and again.

Just Do It

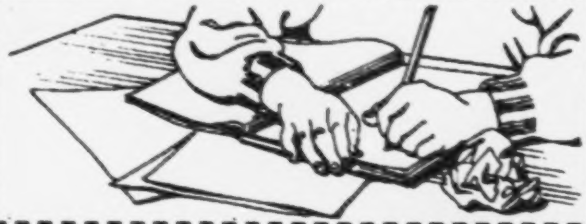
Set up scrap and recycling paper boxes in your classroom. Use scrap for art projects and other activities. Also use BOTH sides of paper when doing school work!

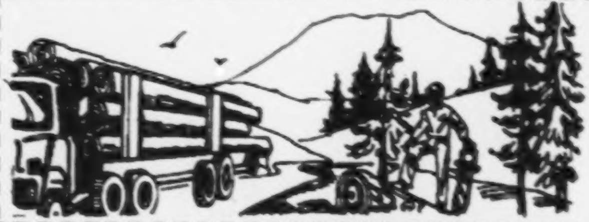
Student Worksheet

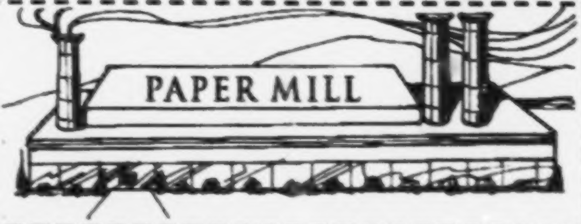
Making Paper: From the Forest to the Classroom

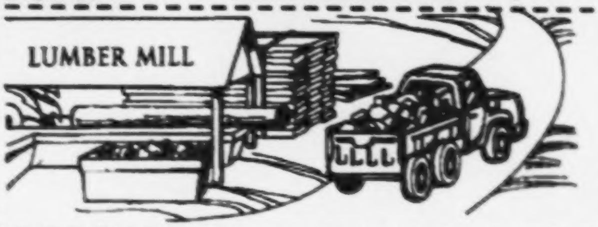
Name: ______________________________

1	2
3	4





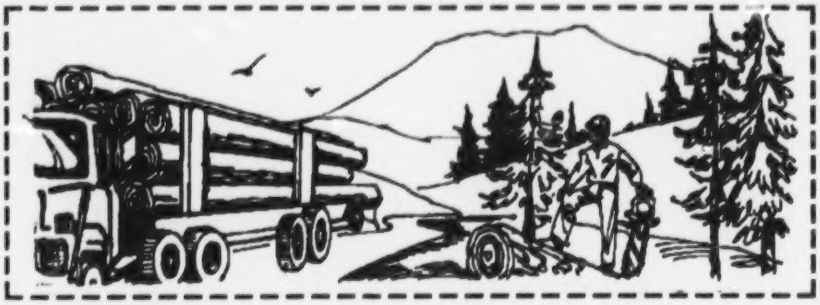


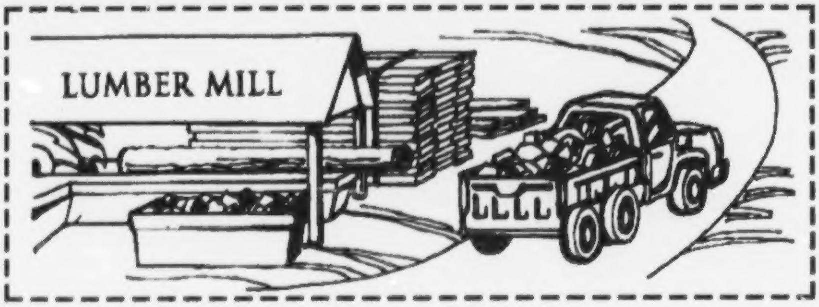

LUMBER MILL

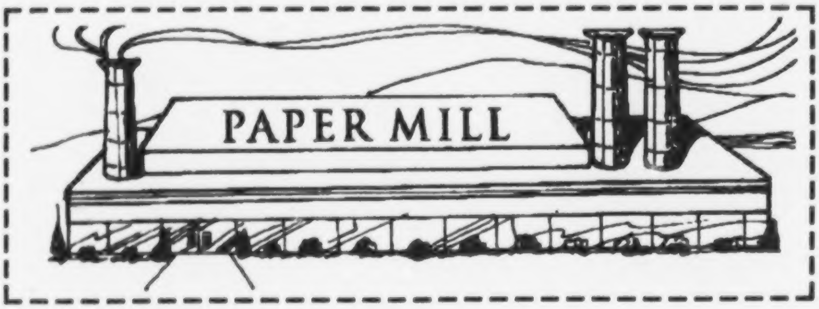
Color and cut out the pictures and paste them into the numbered boxes to show how trees become classroom paper

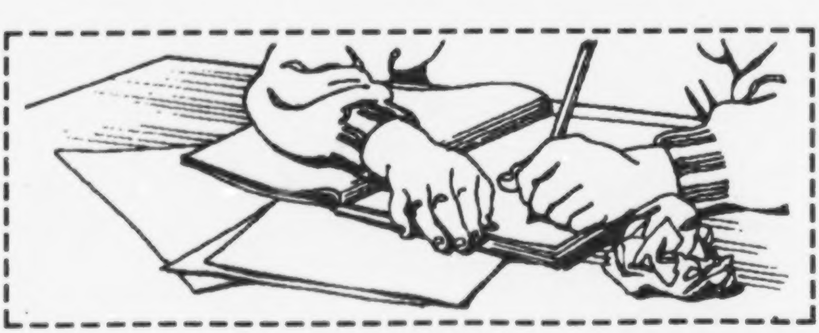
Teacher Transparency

Making Paper: From the Forest to the Classroom



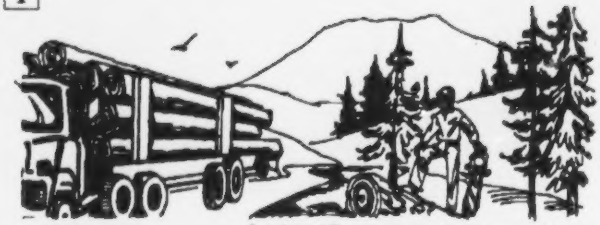

LUMBER MILL





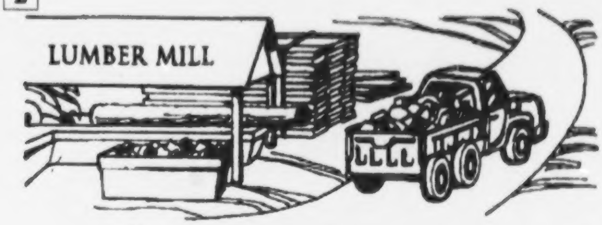
The Paper Cycle

1



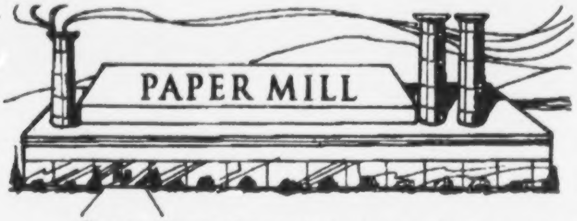
It takes 17 trees to make one ton of paper

2



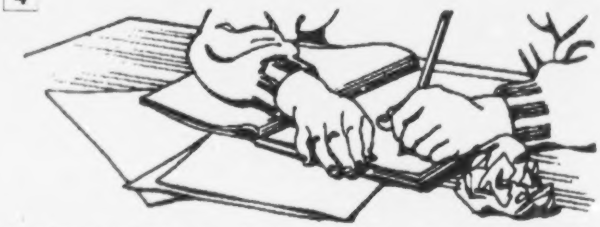
Wood wastes from lumber mills are used to make paper.

3



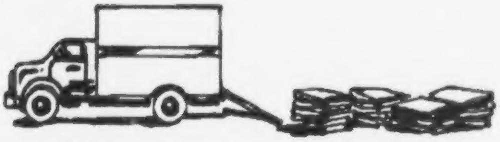
Paper mills turn the wood into paper ready for you to use

4

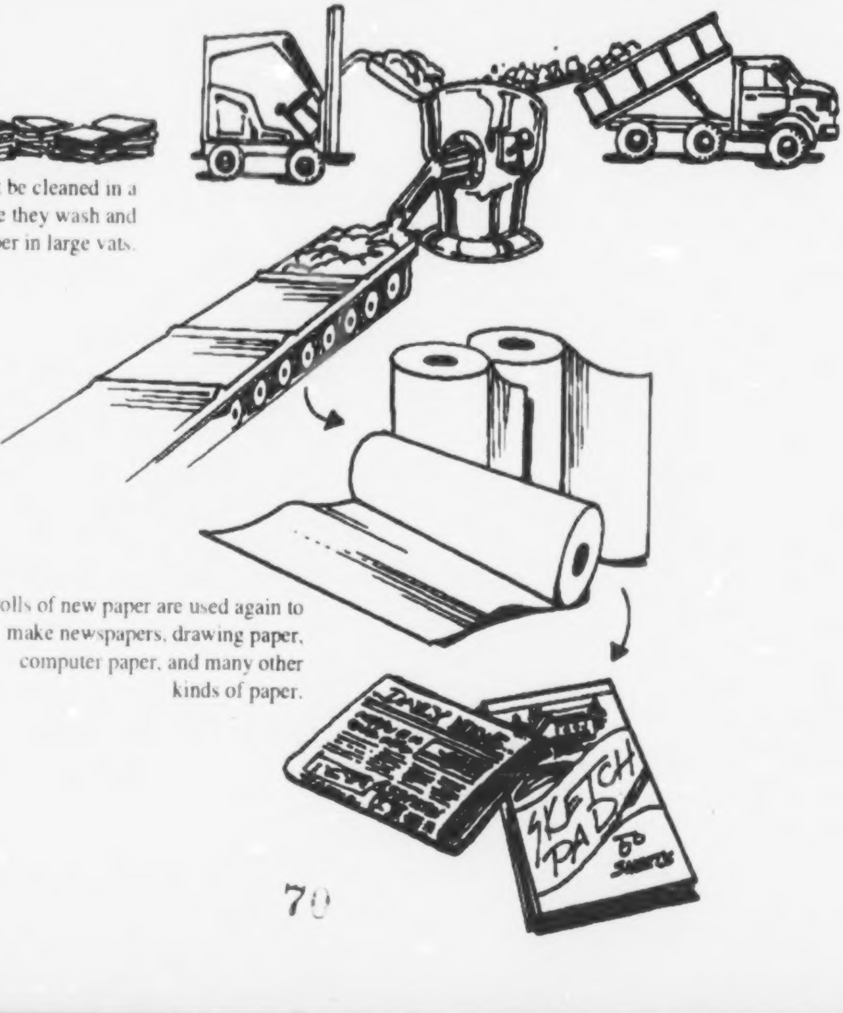


Once paper is used, it should be sent to be recycled, not thrown away.

5



Old paper, like newsprint, must be cleaned in a processing called "de-inking" where they wash and rinse the paper in large vats.



Sometimes newsprint and wood wastes are combined, mixed into a pulp and poured onto large rollers. Other times mostly used paper is processed again.

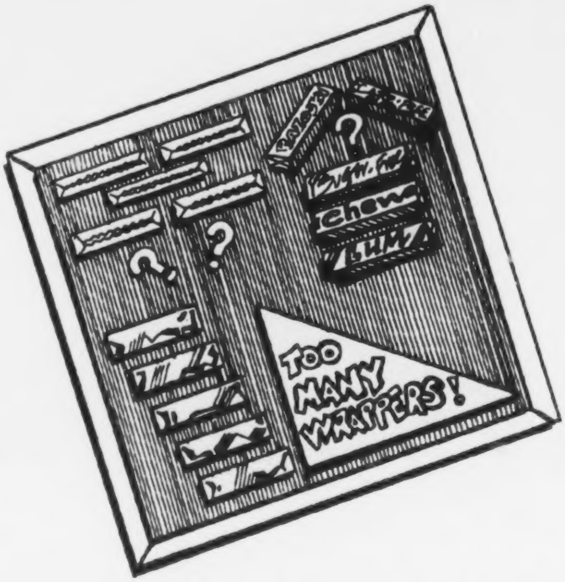
6

The rolls of new paper are used again to make newspapers, drawing paper, computer paper, and many other kinds of paper.

Too Many Wrappers

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: K-1
Objective: Students will examine packaging
Focus: Packaging, reduction
Subject: Social Studies, Art, Math
Materials: Enough packages of gum for each student to have one piece (or other multiple-wrapped treats such as mints), construction paper, glue
Teaching Time: One class period
Vocabulary: Trash, packaging



Learning Objective

Students will:
- understand the drawbacks of excessive packaging
- understand the need to make environmental purchasing choices.

Background

As much as 40 percent, or about half, of household waste, that is what we throw away at home, is packaging. (See the Resource section for more information on packaging.) **Packaging** of some kind is necessary in many cases to protect food and keep it clean and free from germs, but many layers of paper and plastic packaging often add unnecessarily to the waste stream and are not recyclable.

For instance, paper packaging coated with plastic or aluminum prevents it from being recycled.

It is difficult to be aware of how much waste we produce, especially when we throw out one candy wrapper at a time, but a lot of little pieces add up quickly to a surprisingly large amount. We can each help reduce the volume of solid waste by choosing products with less packaging.

Some ways people can reduce packaging waste are:
- don't buy fruits and vegetables wrapped in plastic … they're already wrapped in nature's packaging
- reuse straws and cartons for art projects
- avoid buying packaging that can't be reused or recycled
- buy packaging that can be recycled, such as glass, plastic, and aluminum, and recycle it! *(Find out what is recyclable in your area.)*

Learning Procedure

Ask: Do you think eating one piece of gum will have much effect on the size of a trash pile?

1. **Read and discuss** the poem, *How the Trash Pile Grows.* **Ask:** Do you think this is what we should

DOWN TO EARTH

On Earth Day, April 22, 1992, more than 200 towns in the Netherlands participated in a campaign emphasizing public transportation and bicycles.

Source: 1993 Earth Journal

do, Why? What does it mean by, "oh, no - where is *away*?"

2. Divide students into groups with the same number of students as there are pieces of gum (or multiple-wrapped candy) per package. Pass out one package of gum (different color) to each group, and ask them to carefully unwrap it without tearing the wrappers.

3. Have each group create a poster by gluing all the wrappers and the packaging on a piece of construction paper. Glue wrappers in patterns, grouping them in fives or tens so they can be easily counted.

4. When the posters are finished, ask the children to guess how many wrappers there are, and then to count them. As a class, figure out, if you chewed one pack of gum each week, how many separate wrappers would you be adding to the waste stream each week? Each year? *(As a continuing exercise to see how trash adds up, you may want to select an item such as gum wrappers or aluminum can pull-tabs to have students collect and sort by fives and tens. See how many you can collect in a week. In a month. In a semester.)*

5. Discuss the reasons why there are so many wrappers. Identify the possible purposes of each layer. Ask students how they would package the gum. What are the reasons for their design choices?

6. Ask students to think of other things that their families buy that come in packages. What things have the most number of separate packaging pieces per package? Consider individually wrapped sliced cheese, candy, crackers, single serving instant foods and beverages. If we reduce the amount of packaging, will we reduce the amount of trash? Brainstorm ways to reduce packaging.

7. Explain that many communities are facing the problem of too much trash. There are things we can do to make less trash. Discuss ways to reduce waste:

- Buy larger sizes; they use less packaging than several smaller sized packages (but buy only what you will use.)
- Don't throw away clothing that you've outgrown. Clean and mend it and donate it to a charity, someone else may be able to use it.
- Use washable plates, cups and utensils instead of **disposables**, throw-aways, where practical.
- Use the back side of waste paper for scrap.

Have students think of other ideas.

8. Help students understand that *they* control how much trash they make, so they have to be the ones to decide to make less trash. If each student saved one or two things from the trash each week, it would make a difference.

Questions for the Class

1. Name two types of packaging that are difficult to recycle and two that are easy to recycle.

2. How can you reduce the amount of packaging in your trash can?

3. Have students think of one thing they enjoy eating that has a lot of packaging and one thing with very little. Can they choose to eat the kind that uses less? Does the same food come in different types of packaging, so they can choose less packaging and still have their favorites?

Extension Activities

1. Try the "Wrapping and Unwrapping" activity as a home extension activity.

2. Compare and make displays of "Nature's packaging" and "People Packaging."

3. Have students create collages with snack food wrappers from home or from lunch boxes.

Wrapping and Unwrapping

(a 15 minute Project)

Try this when someone in your family comes home from the store with lots of groceries.

1. Put an empty waste basket near the table. Now start unwrapping the groceries before you put them away. (Note: Only remove extra outside packaging and store wrapping such as plastic fruit bags, do not remove packaging needed to preserve food freshness.)

2. Put all the wrapping in the waste basket. You should collect items such as cardboard boxes, ice cream bags, plastic bags, paper cartons, cardboard cartons.

3. Did you collect a full basket? Examine the contents of the waste basket. Do you think that all those wrappers were really necessary?

How the Trash Pile Grows

Buy it,
Try it,
Throw the Trash Away!

Take it,
Break it,
Throw the Trash Away!

Get it,
Use it,
Finish it,
Lose it,
Wear it,
Tear it,
Throw the Trash Away!

Soda pop, Box top,
Once you Start
You can't Stop.
Buy it,
Show it
Nothing left but throw it:
Throw the Trash Away!
(Oh, no-where is *Away*?)

Action for a cleaner tomorrow.

A South Carolina Environmental Curriculum

For more information about South Carolina and the environment, call the
South Carolina Department of Health and Environmental Control at
1-800-768-7348.

Lunchroom Trash

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: K-1
Focus: Reduce
Subject: Health, Science
Materials: Black marker, one plastic grocery bag, four large paper bags (grocery size), scale
Teaching Time: One class period
Vocabulary: Packaging, excess, reduce

Lunch
Without
Leftovers!

Learning Objective

Students will:

- take a first-hand look at excess packaging and determine ways to reduce waste.

Background

Some foods and other things we buy have a lot of **packaging**, or material used to cover, protect, and market, the product while others use little or no packaging. Consider some examples of "packaging intensive" products (fast food meals, individually wrapped cheese slices). Compare these to products with natural coverings (apples, corn on the cob).

Learning Procedure

1. Label four paper bags – *metal, glass, plastic, paper*. Label the plastic bag: *food*.

Explain to students that everyday activities, like eating lunch, create a great deal of trash. As a class, they are going to take a look at the trash from just one meal. If possible, have students eat lunch in the classroom. (Option: Have the students bring sack lunches to school that day.) Before they eat their lunch, have the children predict which of the five trash bags from Step 1 will have the most trash in it after the meal. List these on the board or have them list their individual predictions on a graph at the front of the room.

2. After they have finished their lunch, have each child (one at a time) separate their lunch "leftovers and trash" into the appropriate bag.

3. Hold up the bags and compare. Discuss the trash that has been collected. **Ask:** Is there an **excess** of packaging? Is some of this packaging unnecessary? How can we change the amounts of trash collected? Is there a better way of making a lunch with no trash?

4. As a class, plan the contents of a No-Trash lunch. (Option: Pack this No-trash lunch for the next field trip or have the lunch the next day at the school.)

DOWN TO EARTH

The Japanese recycle over 45 percent (almost half) of their used paper.

Source: EarthCare Paper Company

Extension Activities

1. Have a picnic where there is no garbage. See the *Plan a Picnic Where There is No Garbage* handout. Have students do the picnic as a weekend assignment and tell the class how they did it.

2. Challenge the class to a game of the Garbage R's, instructions included with this lesson.

Garbage R's

When it comes to garbage there are many R's: *reduce, reuse, recycle, rethink, and reject!* In this game, students think of ways to put the R's to work on an ordinary can of garbage.

To play: 1. Sit with class and brainstorm about trash. On small pieces of scrap paper, write the names or draw simple pictures of ordinary objects you might find in a garbage can: worn out or torn clothing, a glass bottle or jar, plastic sandwich bag, plastic food container, paper napkin, an empty oatmeal box, old magazine, aluminum beverage can, apple core, banana peel, egg shells, milk carton, old toys, junk mail, a newspaper, a juice box, etc. (If you have any trouble thinking of things, look in your garbage!)

2. Put all of the papers in a container: this will be the "trash can" during the game.

3. Reuse a soda bottle to make a spinner. Have students sit in a circle, place the bottle in the middle of the group, and spin it. The student it points to must go to the "trash can" and choose a slip of paper. Then the student tells the group how to remove it from the garbage by referring to one of the R's of trash: *reduce, reuse, recycle, rethink, reject or others.* For example, the student could choose to **reduce** by using a cloth napkin instead of a paper one, recycle a glass jar, dispose of food waste by composting, reuse a torn shirt by making it into rags, reject by refusing to purchase food over packaged in plastic, or rethink buying an item that is not made to last.

4. When the game is finished, see if anything is left in the trash can. Most likely there will be a few things that must be discarded. Can anyone think of an alternative or another use for these objects?

Reduce

Reuse

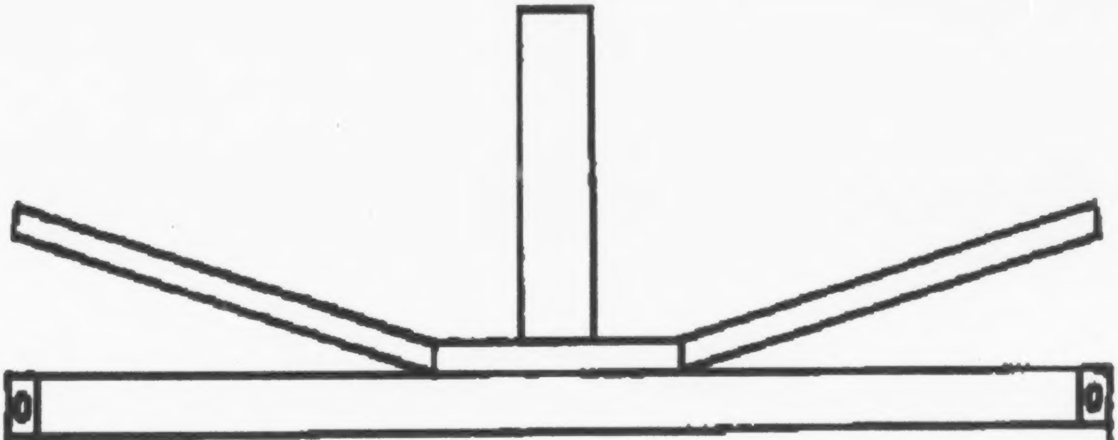
Recycle

Reject

Rethink

Plan A Picnic Where There Is No Garbage

Dear Parents: This weekend we'd like your family to enjoy a picnic ... a No-Trash picnic that is. At school, your child is learning how to substitute reusable and recyclable items for disposable ones. For recyclable items choose those that are recyclable in your community. We'd like to get the entire family involved in this by trying a No-Trash picnic. Thank you for your participation. Watch out for the ants!



Alternatives to Disposable Food Packaging

Food Item	**What's Recyclable**	**What's Reusable**
Beverage	• Aluminum Soda Can • Glass Bottle • Plastic soda bottle	• Thermos with cups • Refillable glass bottle • Plastic squeeze bottle
Sandwich	• Aluminum Wrap	• Plastic sandwich box
Dessert	• Apple, Peach, Pear (eat and digest the package then compost the cores!)	• Durable plastic cup with lid for fruit/pudding • Plastic pie or cake box
Place settings		• Metal utensils • Cloth napkins • Table cloth, blanket, beach towel
Carrying Container	• Plastic grocery bag • Brown paper bag	• Metal/plastic lunch box • Tote bag • Wicker picnic basket

Action for a cleaner tomorrow.

A South Carolina Environmental Curriculum

For more information about South Carolina and the environment. call the
South Carolina Department of Health and Environmental Control at
1-800-768-7348.

(Re)Show & (Re)Tell

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: K - 1
Focus: Reuse
Subject: Language Arts, Art
Materials: Objects that may often be discarded (mate-less socks, empty cartons, etc.) that can be refashioned into new things
Teaching Time: One class period
Vocabulary: Reuse, waste reduction

Learning Objective

Students will:

- discover that many objects can be reused
- understand that new use is reuse.

Background

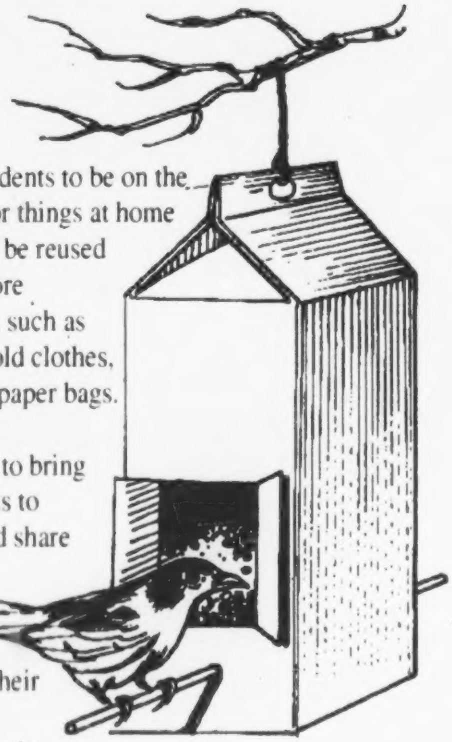
One important way to cut down on the amount we throw away (**waste reduction**) is to get in the habit of finding new uses for items, called **reuse**.

Learning Procedure

1. Display objects in the class that are often thrown out after the first use, such as cardboard tubes and boxes, plastic milk cartons and TV dinner trays. Hold up an item and ask students to think of ways that it could be used again. Do this with several items.

2. Discuss the benefits of reusing things. *(It is fun and creative, it saves us money because we don't have to buy something new, and we don't have to pay to throw it out.)*

3. Have students create an art project from trash items. See the handout, *It's Fun to Reuse.*



4. Ask students to be on the lookout for things at home that could be reused again before discarded, such as old toys, old clothes, plastic or paper bags.

Ask them to bring these items to school and share with the class their ideas for reusing the item.

Questions for the Class

1. Can you list three things you or someone in your family threw away lately that you could reuse?

Extension Activities

1. Build a model of your community using milk cartons as houses and other reuse items for buildings, street lights, fire hydrants, etc.
2. Read the poem, *Hector the Collector* by Shel Silverstein.
3. Ask students to bring to class a treasured object that they saved from the trash and reused.
4. Have students ask their family to save old greeting cards to bring to class. Reuse these cards to make new ones and to illustrate story ideas.

DOWN TO EARTH

In the United States, paper toys and games make up 3 percent (or three items out of 100) of our waste stream. Virtually none of this is recycled.

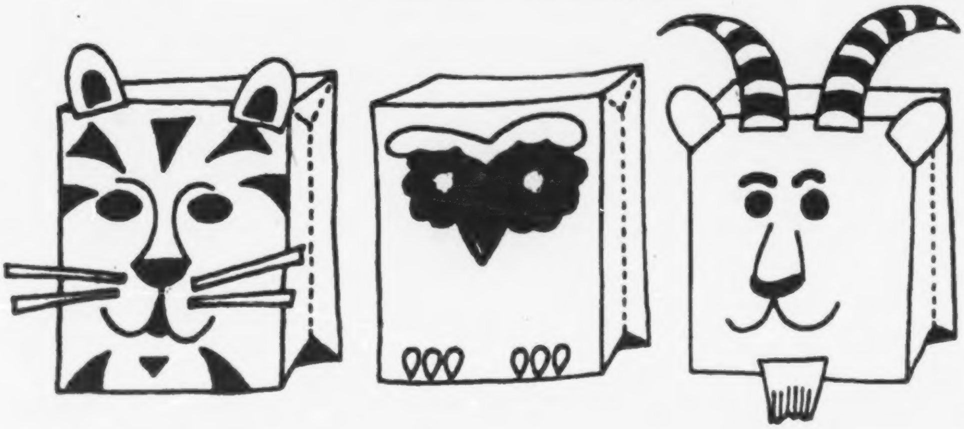
Hector the Collector

by Shel Silverstein

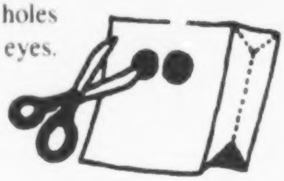
Hector the Collector
Collected bits of string,
Collected dolls with broken heads
And rusty bells that would not ring.
Pieces out of puzzles,
Bent-up nails and ice-cream sticks,
Twists of wires, worn-out tires,
Paper bags and broken bricks.
Old chipped vases, half shoelaces,
Gatlin' guns that wouldn't shoot,
Leaky boats that wouldn't float
And stopped-up horns that wouldn't toot.
Butter knives that had no handles,
Copper keys that fit no locks,
Rings that were too small for fingers,
Dried up leaves and patched-up socks.
Worn-out belts that had no tracks,
Airplane models, broken bottles,
Three-legged chairs and cups with cracks.
Hector the Collector
Loved these things with all his soul–
Loved them more than shining diamonds,
Loved them more then glistenin' gold.
Hector called to all the people,
"Come and share my treasure trunk!"
And all the silly sightless people
Came and looked … and called it junk.

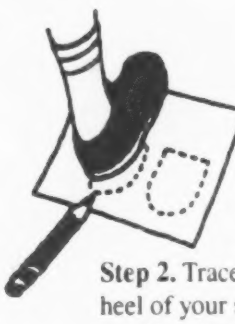
It's Fun to Reuse!

Go ahead … be a goat!



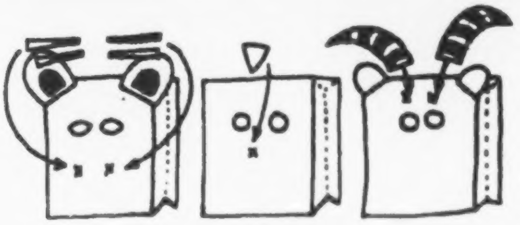
Step 1. Open a large paper bag and cut holes for your eyes.





Step 2. Trace the heel of your shoe on another piece of paper. Use these to make your ears. You'll need to cut them out and glue them to the bag.

Step 3. Cut out tiger whiskers,or goat horns or an owl's beak from colored paper and glue these on.

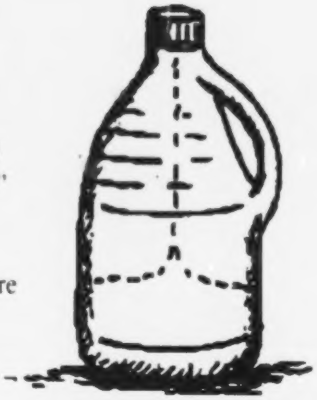


Step 4. Color your mask to finish your animal mask. You'll be a big hit with your family. What other animals can you think of to make out of paper bags?

Jugs of Fun

There are tons of things that can be made from old milk and bleach jugs. Make sure they're clean as they can be!

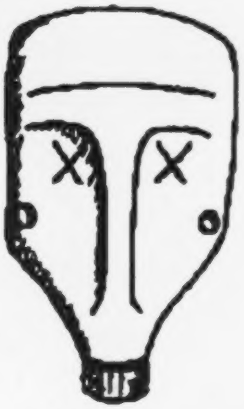
Materials: To make a mask, each student will need one clean jug; two pieces of string or yarn about 20" long; colored markers or acrylic paints and brush; scissors; a hole punch, and sandpaper. To make a basket, each student will need one clean jug; a square of felt 5" x 8"; pipe cleaners; cotton balls; "eyes" (from a craft store, optional); glue and scissors.



Procedure:

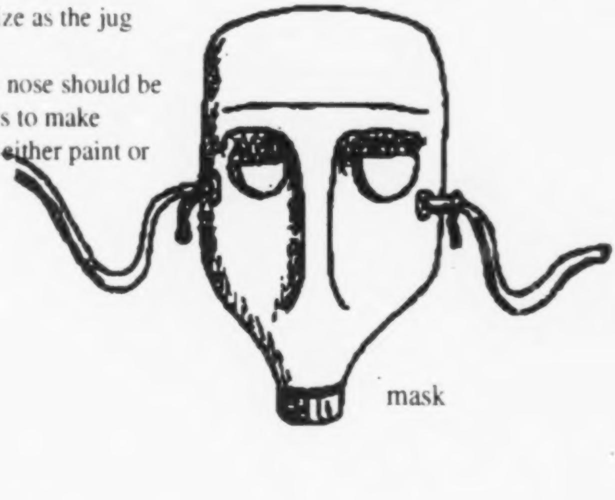
Mask

1. Trace the shape of the mask onto each bottle. This is where the students will cut the jug.
2. Punch holes in the sides of the mask then attach the strings.
3. Have the students try on the masks and help them mark the position for the eye holes. Remove the mask and cut the holes.
4. Sand any rough edges and decorate.

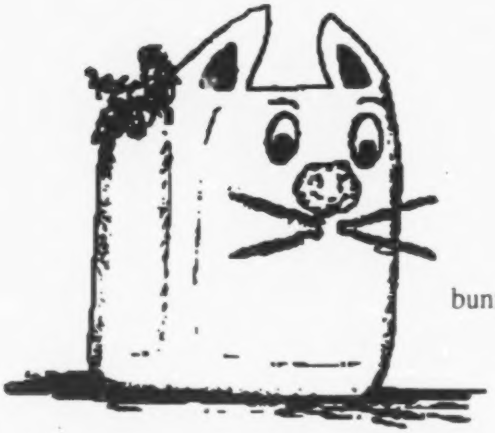


Bunny Baskets

1. Draw the pattern for the bunny ears on each milk jug, continue around the back of each jug with a straight line. Remind students to keep the handle intact while cutting out the pattern.
2. From the felt, cut two triangles the same size as the jug ears.
3. Poke two holes on either side of where the nose should be and weave the pipe cleaners through the holes to make whiskers. Glue a cotton ball for the nose and either paint or glue the craft eyes in place.



mask



bunny basket

Yesterday's Paper

Preparation Time: [✓ Easy-To-Do] Moderate Extensive

Grade: K-1
Focus: Reuse
Subject: Science, Language Arts
Materials: Large boxes, junk supply box, paint, markers
Teaching Time: 30 minutes, ongoing reuse projects
Vocabulary: Reuse

Learning Objective

Students will:

- examine how to reuse things to make less waste.

Learning Procedure

1. Hold up a cardboard box. **Ask**: What can we make of this box? Write a few ideas on the board.

2. As a group reading activity, have students read the poems, *Yesterday's Paper* and *Johnny*. Afterwards, have students brainstorm more ideas of how a box can be used and used again, or **reused**.

3. As a class project, you may want to assign a theme so that the boxes can be a part of the classroom. For example, if you are working on a "space" unit, you may want students to make their boxes into space shuttles. If you are working on trains, you may want to make a "box train" for the classroom.

Questions for the Class

1. Why is it important to reuse things?
2. What happens to things we don't reuse?

Extension Activities

1. Challenge students to see how long they can keep using (and reusing) one reusable object such as a piece of paper or a plastic bag. Results could be graphed on the board.

2. Make a classroom Earth Book. Reuse brown paper grocery bags for pages of the class book. Have students draw pictures of how they can help protect the environment by reusing things. Sentences can be added to go with pictures. You may want to add the finished book to your class library.

3. Have students create their own *Earth Pledge* to do their part to protect the environment. Provide each student with a copy of the earth pledge included with this lesson or have students create their own. Have students color the earth and write their own earth pledge (student may dictate their pledge.)

You may want to display the finished products in the classroom or hallway.

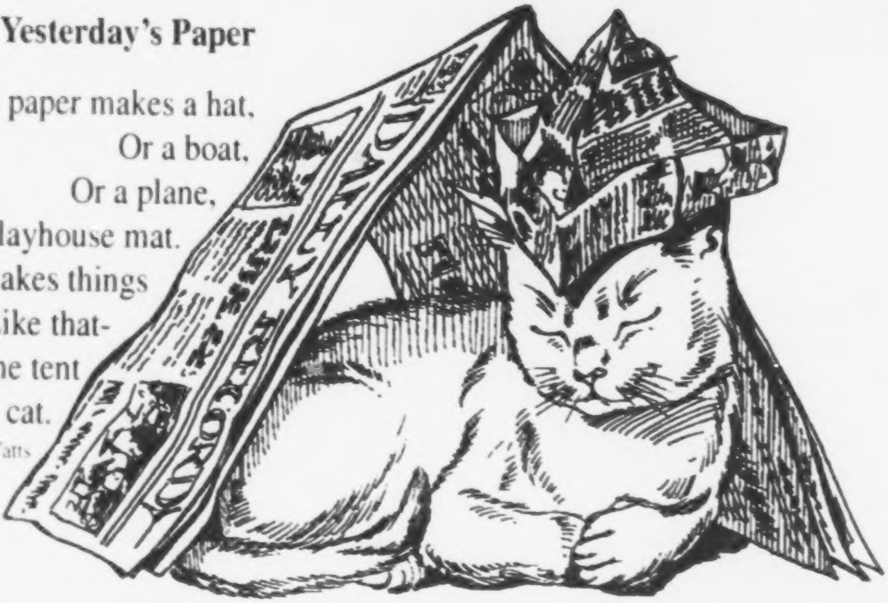
DOWN TO EARTH

Reusing things is not a new idea, just a good one. Native Americans reused animal skins to make everything from clothing to tents to drums.

Yesterday's Paper

Yesterday's paper makes a hat,
Or a boat,
Or a plane,
Or a playhouse mat.
Yesterday's paper makes things
Like that-
And a very fine tent
For a sleeping cat.

Mabel Watts



Johnny

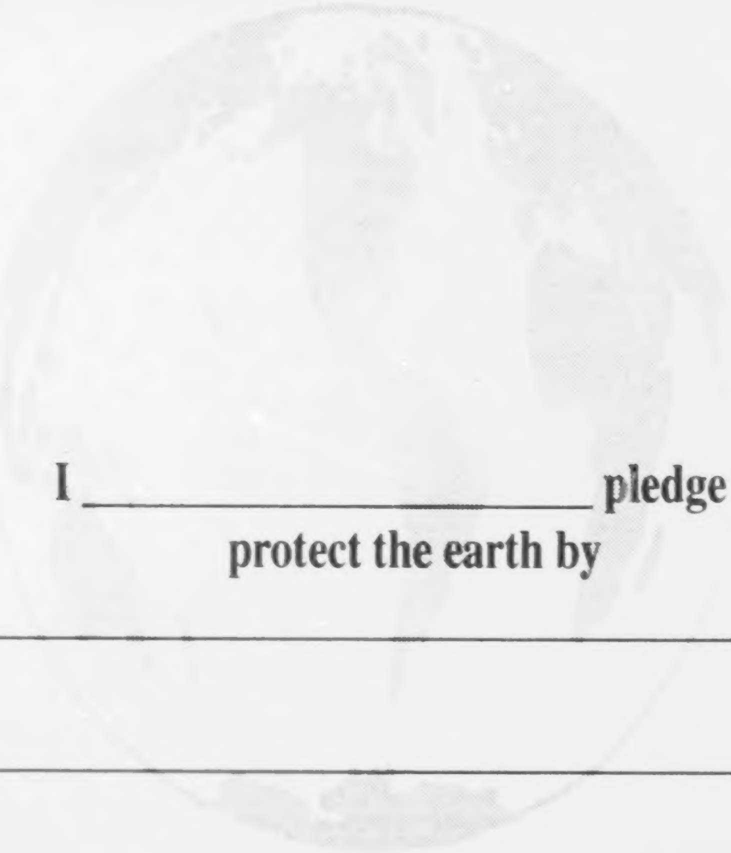
To Johnny a box
is a house
or a car
or a ship
or a train
or a horse.

A stick
is a sword
or a spear
or a cane,
and a carpet
is magic,
of course.

Marci Ridlon

Just Do It

Plan a reuse center for the classroom.
Save scrap paper, used crayons, boxes, etc.
and plan a special Reused Art project.



I ______________________ pledge to
protect the earth by

____

Name ____

Action for a cleaner tomorrow.

A South Carolina Environmental Curriculum

For more information about South Carolina and the environment. call the
South Carolina Department of Health and Environmental Control at
1-800-768-7348.

A Rotten Idea

Preparation Time: Easy-To-Do Moderate **Extensive**

Grade: K-1

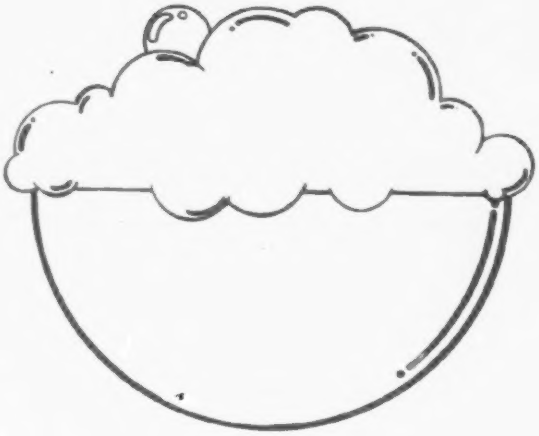
Focus: Composting

Subject: Science

Materials: Large clear plastic or glass jar, food scraps (fruit peels, bread), leaves, grass clippings, soil. For ingredients for Compost Pile Cake, see recipe included.

Teaching Time: Variable

Vocabulary: Waste, decompose, compost, natural recycling, landfill



Learning Objective

Students will:

- examine how some wastes are recyclable through composting.

Background

Years ago, when many South Carolinians lived on farms and in rural areas, food scraps were saved as feed for animals. Yard clippings were mulched along with some scraps and were used to make a worm bin for fishing bait. Other clippings were plowed into the soil to enrich it. Very little of any thing was **wasted**. (For more information on composting, see the Resource Section.)

Today people are reexamining the benefits of **natural recycling** and are **composting** their yard wastes and some food wastes in special backyard compost bins. Composting produces a product that is good for the soil. Composting is a natural process in which organic materials are turned into a soil-like product through decomposition, or breaking down by rotting.

South Carolina laws regarding disposal of yard wastes have changed. As of May 27, 1993, all yard wastes are banned from landfill disposal and are not to be included with household trash. Many communities in South Carolina, including the city of Columbia, now have separate curbside pick up for yard waste and take it to large community composting facilities.

Learning Procedure

1. Have students collect various food scraps from the cafeteria (no meat or cheese). Have them collect leaves, grass, and other plant materials from the school yard. (You may want to ask the custodian to save grass clippings for you.)

2. Place two inches of soil in the bottom of a clear glass or plastic jar. Moisten for best results. Place food, leaves, and grass scraps on top of the soil in several, repeating layers.

DOWN TO EARTH

In 1991, the Walt Disney Company bowed to objections from environmentalists and abandoned plans to build a giant resort in Long Beach, California.

Source: 1993 Environmental Almanac

3. Leave the jar open and place on a window sill or other location where it will not be disturbed. Observe the jar daily, noting any changes. Water a little every week and stir contents.

4. On the first day, ask the students to record how the materials look and smell. You may want to do this as a group activity and keep a master log of their observations.

5. On the second day, ask students what they think is happening to the materials. Introduce the term **decompose** as the items break down and rot. Have students observe the waste for several weeks.

Option: Use several jars, have students compare how different materials decompose. Use food scraps, yard wastes, paper, plastic pieces, etc. in separate jars. Have students observe how these materials vary in the way they decompose. Remind students that things do not decompose easily in the landfill where there trash goes. For things to decompose, they need light, air, and water ... things not found in a landfill.

6. Discuss with students the benefits of a backyard compost pile. *(Reduces waste going to the landfill or incinerator, provides rich soil for home gardens.)*

Questions for the Class

1. What types of things decompose quickly in a compost bin? *(Natural items such as yard clippings and fruit peelings.)*

2. Why should you keep yard waste separate from your household trash? *(Yard wastes are banned from South Carolina's landfills. This saves landfill space for items that do not decompose and can not be composted.)*

Extension Activities

1. Have students sing *Banana Peel Blues*, and create new verses of their own.

Banana Peel Blues

(sung to the tune of *Take Me Out To The Ball Game*)

Take me out to the compost;
Take me out to the heap.
Grind me up in a food grinder;
I don't care if I'm chopped up to bits,
Cause it's root root root for recycling;
If all compost we'll gain.
For it's 2, 4, 6 weeks I'm out to the old garden.

2. Share *It's Fun to Make a Compost Pile Cake* with students. This activity is a fun follow up to your classroom composting experiment, and shows students how things are layered in the compost pile to create something exciting. See the recipe for the Compost Pile Cake included with this lesson.

Ideas for creating the Compost Pile Cake include:

- Reinforce the importance of following directions and cooperating by having students bring in the ingredients for the Compost Pile Cake and by letting students mix the ingredients.
- Divide the class into small groups to mix and prepare different layers of the Compost Pile Cake. Each student should have a task. Point out the skills used in making the recipe, such as measuring correctly (math), following directions (reading and listening), and have students observe changes and reactions (as in adding milk to the powered pudding mix). Ask the class what would the Compost Pile Cake taste like if an ingredient was missing, or if someone forgot to do his or her part.

It's Fun To Make A Compost Pile Cake!

As an extension activity, have students bring in ingredients and help prepare **A Compost Pile Cake.**

Ingredients:

3 1/2 cups Milk
1/2 cup Margarine
12 ounces Prepared Whipped Cream topping
8 ounces Cream Cheese
1 cup Powdered Sugar
one 20 ounce package of Chocolate, Vanilla Cream-filled Sandwich Cookies (crushed to simulate dirt)
two 3.4 ounce packages of Vanilla Instant Pudding
six Gummy Worms (any flavor will do)
1 cup chopped nuts (pecans or walnuts)
1 cup chopped maraschino cherries
1 cup coconut (you may want to use green food coloring to simulate grass clippings)

How to prepare:

1. In a large bowl mix margarine and cream cheese until soft, add powered sugar (to taste) and mix well.
2. In another large bowl, mix well the milk, pudding mix, and whipped cream.
3. Combine these two bowls and mix well.
4. In a large clear container such as a large glass salad or punch bowl, place Gummy worms along the side of the bowl.
5. In the large clear bowl, alternate layers of crushed cookies (reserve about one cup), pudding mixture, nuts, coconut, and cherries. Finish with a layer of cookies on top.

Note: For effect, serve the Compost Cake to the class using a garden spade or small shovel.

Feel free to adapt the recipe to meet your own tastes and dietary requirements.

Action for a cleaner tomorrow.

A South Carolina Environmental Curriculum

For more information about South Carolina and the environment, call the
South Carolina Department of Health and Environmental Control at
1-800-768-7348.

My Body Needs Water

Preparation Time: **Easy-To-Do** Moderate Extensive

Grade: K – 1

Focus: The importance of water

Subjects: Science, Health, Art

Materials: two quarts of water in a clear container, tomatoes and paring knife for TEACHER USE ONLY, slices of bread, four-foot pieces of newsprint (one per student), yardstick or tape measure, crayons

Teaching Time: One class period

Learning Objective

Students will:

- observe an example of the body's daily water need
- discuss some examples of body fluids
- explore some foods with a high/low water content
- compare parts of the body for water content
- represent their body's water content.

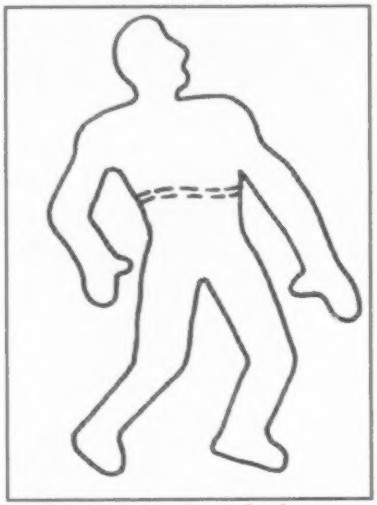
Background

To be healthy, your body needs about two quarts of water each day. You must have water to live. You can live without food for a month or more, but you would probably die in less than a week if you had no water.

Your body is about two-thirds water. That is more than half. It is spread around the various organ systems of your body. The blood has a lot of water while the bones don't have as much.

Learning Procedure

1. Before sharing the Background material, place two quarts of water in a pitcher on your desk.



Explain that this is approximately the amount of water each of our bodies need every day. **Ask:** where can you find some very visible uses of water in your body? (*saliva, tears, sweat, urine*) Discuss the job of saliva (*helps digestion*), tears (*cleans eyes*), sweat, and urine (*gets rid of waste*). Some of the water in our bodies is found in our tissues, organs, blood, and bones. Discuss how blood and bones are different.

2. Some of the water our body needs is found in the food we eat each day. Compare a tomato and a piece of bread. **Ask:** Which has the most water? How do you know? Cut open some tomatoes and tear apart the bread. Pass them around to the students. Have the students name some other foods they think might contain a lot of water.

3. Make a picture to represent how important water is to your body. Have the students work in pairs. Give each student a piece of newsprint and have them take turns lying on the newsprint. Draw each other's outline on the newsprint.

DOWN TO EARTH

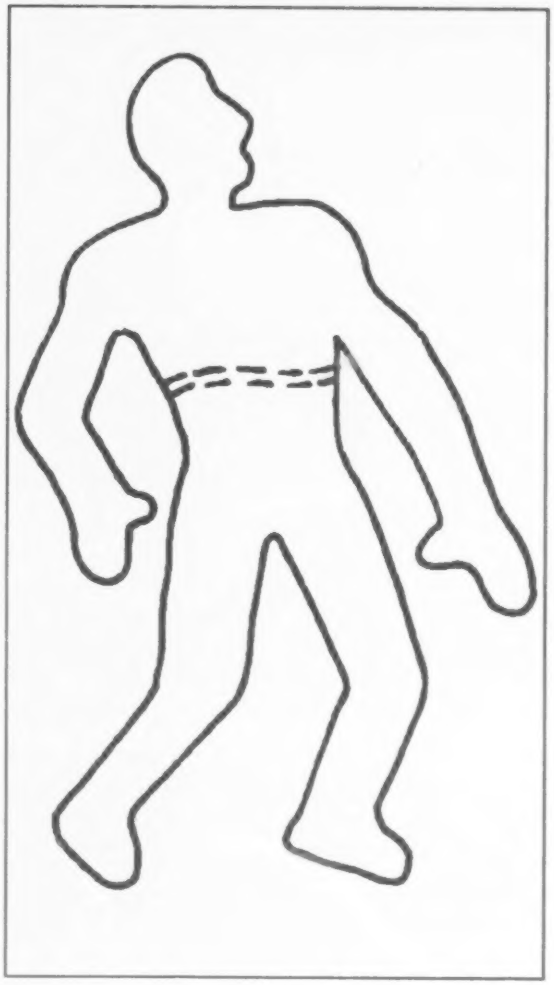
In 1990, Americans spent $2.2 billion for more than 2 billion gallons of bottled water. We consumed an average of eight gallons apiece.

Source: The Information Please Environmental Almanac, 1994

4. As the students finish, measure the length of the outline (the height of the student) and mark off about two-thirds of the body with a wavy line. Point out that this is the amount of water in each body.

5. Give the newsprint back to each student to color. Draw a face on the outline and color the water part in blue. NOTE: Be sure to emphasize that we are representing the amount of water throughout our bodies. It is not all found in just the lowest part.

6. Hang "Our Watery Selves" around the classroom to remind us of water's importance.



Extension Activities

1. Find the most watery looking food served at dinner tonight. Report to the class tomorrow.

2. Borrow a triple beam balance from a nearby middle or high school science teacher. Select a large, fresh apple. Carve two eyes, a nose and a mouth on it. Weigh the apple and place it on a sheet of paper in a cool, dry spot in the classroom. Write the apple's weight on the paper in big numbers and letters. At the end of the week, weigh the apple again. Discuss what has happened to the weight. Has the apple gained or lost weight? Why? Where did the weight go? What has happened to the apple's appearance? Even though many of the concepts here might be new for young children, most should be able to see: 1) a difference in the apple after one week, and 2) that the apple is much dryer and has lost much of its water. Ask the students what might happen to the apple after another week. Let the apple sit another week and have the class check their hypothesis by repeating the observations.

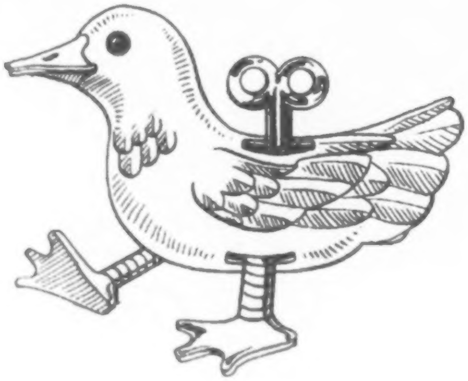
Just Do It

Drink plenty of water. Try switching to water instead of soda or other drinks.

What's Energy?

Preparation Time: **Easy-To-Do** Moderate Extensive

Grade: K - 3
Focus: Understanding energy and how to conserve it.
Subject: Science
Materials: Handouts included with this lesson
Teaching Time: Several class periods, ongoing
Vocabulary: Energy, heat, light, conservation



Learning Objective
Students will

- define energy
- see how they use energy at home and school everyday
- try several tips to help conserve energy.

Learning Procedure
This lesson includes a collection of simple activities for young children to help them begin to understand the concept of energy.

1. **Energy** is motion

a. **Ask the class:** Have you ever heard someone say, "You have lots of energy!" What does this mean? Can people have energy?

Have students demonstrate "using their energy" by walking in place.

Ask: What keeps us going?

Discuss how our bodies use food and water to make energy, and how our bodies need rest.

Ask: What can we do with our energy? Talk about playing, running, reading, talking, etc.

Show students how their energy as motion can be used to accomplish things. Place a stack of items (blocks, books, etc) at one end of the class and have several students line up and take turns relay-race style moving the items across the room to a shelf.

Keep a list of all the ways students use their energy as motion during the day. *(Walking, eating, running, picking up toys, etc.)*

b. Bring in several wind up toys and let them move across the floor. **Ask:** Do toys have energy? Let students take turns putting the toys in motion. **Ask:** Where do the toys get their energy? Do they eat and rest like we do? *(No. The wind up toys have the energy created by winding them up and releasing them.)* Use a rubber band to show how when you stretch it out and release it, it moves across the room as its energy is released.

Ask: How did you get to school today? *(Cars, buses)* Where does your car/bus get the energy to make it move or go? *(Talk about how machines such as your car use gas as the source of energy.)* What other sources of energy make machines move? *(Batteries, electricity.)*

DOWN TO EARTH

The energy consumed in the United States is 40 percent petroleum, 23 percent natural gas, 22 percent coal, and 7 percent nuclear.
Source: *The Information Please Environmental Almanac, 1993*

c. Bring a pinwheel to class and show students how wind can be used to create energy. Wind makes the pinwheel move and turn. Talk about how wind moves the leaves in the trees. Use pencils, pins, and paper and let students create their own windmill.

2. Energy is **heat**

a. Use a large thermometer to compare the temperature outside in the sun and shade. **Ask:** Why is the temperature higher in the sun? *(The sun's energy is heat.)*

b. Demonstrate how our bodies give off energy as heat. Bring in several blankets and/or jackets, hats, and scarves. Have students put on these layers and feel the heat build up. **Ask:** Why do we wear coats in the winter? *(To keep our body heat in to help us keep warm when it is cold outside.)* Why do we wear light clothes in summer? *(To let the heat out when it is warm outside.)*

3. Energy is **light**

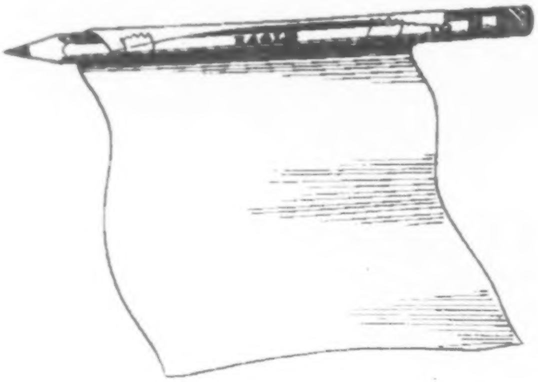
a. Turn off the lights so that the classroom is dark and then light a candle. Explain how the candle's flame gives off energy as light and heat.

b. Bring in a flashlight. Turn off the lights so that the classroom is dark and then turn on the flashlight. **Ask:** Where does the flashlight get its energy to make light? *(The batteries.)* Explain that batteries release energy. Have students list other battery operated items. **Ask:** Where do the lights in the classroom get energy to produce light? *(From electricity.)* **Ask:** Have you ever been at home or school when the electricity went out? *(Talk about how the lights won't work without the source of energy.)*

4. **Conserving** energy

a. **Ask:** What makes our school warm inside in the winter? Talk about the school's heating system. Show students the heat registers where the warm air comes out. Talk about the source of energy for the heat. **Ask:** Why do we need to keep the doors and windows shut in the winter? *(To keep the warm air in and the cold air out.)* What happens if we leave the windows open? *(The warm air goes out and the room gets cold, plus the heater has to work harder – using more and more energy – to warm the room.)* Explain to students that sometimes, even when the windows are closed, cold air tries to slip in. When cold air comes in, we have a draft. This is not good!

Tell students that since we cannot see the cold air coming in, we need to make a special **Draft Detector**. Our Draft Detector will show us if our windows are closed tightly and if the cold air is staying outside where it belongs.
To make Draft Detectors use pencils or plastic drinking straws and tape a facial tissue across it to create a little flag. (See illustration.)



When your Draft Detector is held near a draft, it moves. Test your Draft Detectors at school. Send the Draft Detector home with students along with the explanation for parents on how to use it with their children. The next day let students tell about their experiences and what they found.

Extension Activity

For reading students, use the Conserving Energy Checklist. Have students take the list home and share it with their families. Which conservation tips are the easiest to do?

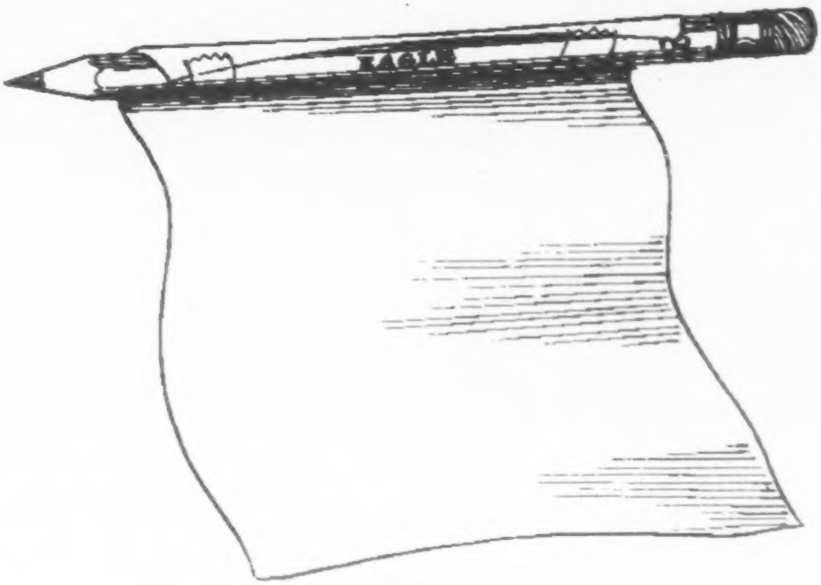
Is Your House Drafty?

Your child has been learning about energy and about conserving it. Please take time to do this quick and easy experiment with your child!

Test your home for air leaks by holding the Draft Detector near the edges of windows and doors.

Movement of the tissue, shows movement of air!

Note: Your forced air heating system must be off to use the Draft Detector or you'll get false results.



THE DRAFT DETECTOR

When the Draft Detector is held near a moving stream of air, it moves with the air. Vertical currents of air are desirable in a house.

If a house is well sealed, hot air will rise and be replaced by heated air near the floor. As hot air from the ceiling cools off, it will sink and be replaced by heated air from the heating system.

A house that leaks around doors and windows and doors will permit the heated air to escape and cold air from the outside to enter and disrupt these ideal currents. About 10 percent of heat can be wasted this way.

To prevent air from seeping into the house, caulk windows and use weather stripping around door frames.

Conserving Energy Checklist

✔

- ☐ Cut off the lights when leaving an empty room.
- ☐ Turn off the TV when no one is watching it.
- ☐ Save water by taking quick showers.
- ☐ Close the refrigerator door as quickly as possible, decide what you want to get out before you open the door.
- ☐ Use cold water to wash your clothes when possible.
- ☐ Never let the water run when you do dishes or brush your teeth.
- ☐ In the winter, close the curtains at night. During the day, open curtains to let in sunshine.
- ☐ In the summer, close curtains that let in the hot sun in morning and afternoon.
- ☐ In winter, keep the thermostat at the lowest comfortable setting, about 68 degrees.
- ☐ In summer, keep the thermostat at the highest comfortable setting, about 78 to 80 degrees.
- ☐ When the house is being heated or cooled, keep doors and windows closed. Go in and out quickly.

We are learning about energy and conserving energy.

There are many things that we can do at school and at home to save energy.

Please read this list with your child and talk about saving energy at home. Have your child check the energy saving ideas that your family can do.

Action

cleaner tomorrow.

TABLE OF CONTENTS

GRADES 2 – 3

Title	Discipline	Focus	Page
Litter is Waste Out of Place	Social Studies. Science. Math	Sources of Litter	1
Garbage Snooping	Social Studies. Science. Language Arts	Home Waste Stream	5
What's Hazardous	Health. Social Studies. Science	Home Hazardous Waste	11
Taking Trash Where?	Social Studies. Science. Art. Language Arts	Disposal	15
Mining the Landfill	Social Studies. Language Arts	Landfill and Resources	19
Musical Resources	Science. Physical Education. Music. Language Arts	Resource Depletion	21
Pick An Item. Any Item	Social Studies. Language Arts	Purchasing Decisions	27
Maybe It's Not A Dream	Language Arts. Social Studies.	Affects Pollution	29
Ads Add Up	Language Arts. Math	Reducing Waste	31
It's In The Bag	Social Studies	Reusing Waste	33
Crayon Trash Stash	Science. Art	Reusing Waste	35
My Bag	Science. Math. Language Arts	Recycling	37
Foiled Again!	Social Studies. Art	Recycling. Packaging	41
Paper Chase	Math. Social Studies. Art. Science. Language Arts	Recycling Paper	45
The Swap & Shop & Yard Sale Rap	Social Studies. Language Arts. Music. Art	Reusing and Repairing	51
Grandparent's Toys	Social Studies. Language Arts	Reusing	53
Yule Recycle	Science	Decomposition. Mulch	55
Soots Me	Science. Social Studies	Open Burning	57

The River Flows Along	Science, Social Studies, Health, Art	Water Pollution	59
Runoff Race	Science	Water Pollution	63
How Conservative Are You?	Science, Math, Art	Water Conservation	67
The Water Cycle	Science, Drama, PE	Water Cycle	69
The Mini Water Cycle	Science, Meteorology	Water Cycle	75

Litter is Waste Out of Place

Preparation Time: **Easy-To-Do** Moderate Extensive

Grade: 2 - 3
Focus: Sources of litter, waste disposal
Subject: Social Studies, Science, Math
Materials: Examples of litter, grocery sacks, old newspaper, gloves (students bring from home)
Teaching Time: Variable
Vocabulary: Litter, demolition, loading docks, pedestrians, receptacles

Learning Objective

Students will:

- pick up litter and discuss what it is, why it is where it is, where it comes from
- suggest methods to control litter.

Background

For more information on litter and its affect on South Carolina, see the Resource section.

Litter is trash that has been discarded in improper places. Many communities recognize the sources of litter and develop programs and educational materials to teach people how to keep waste from escaping and becoming litter. In South Carolina, Keep America Beautiful, Inc., sponsors many litter prevention programs and activities.

- Home garbage - Use only trash containers with tight fitting lids. Paper or plastic bags can be opened by animals. Trash cans without lids or with loose lids can be knocked over by animals and the wind can move the trash several blocks, or even miles.

- Business trash - Tight, closed lids and even locks are sometimes needed on containers.

- Truckloads - If loads are not tied down, many dangerous materials fall or are blown from the truck. Loose material is blown out of truck beds. Many people don't think about putting on tarps and some don't know that they are accidentally losing parts of their load. Roads to the dumps are easy to follow because of all the litter along the roadway.

- Construction and **demolition** sites - Fences around construction sites keep materials from flowing out into the neighborhood. Putting waste materials into proper containers and tarping truck loads keep construction sites clean and construction and demolition materials off our roads.

In South Carolina, the fine for littering can be as much as $1,000 and a prison sentence.

• **Loading docks** - Keeping storage bins or dumpster tops closed and the area clean keep this material in place and away from the rest of the neighborhood.

• Motorists - Car litter bags and litter containers at rest areas, gas stations and fast food stores are important to controlling auto littering.

• **Pedestrians** - Sidewalk litter **receptacles** and good habits help control this source of litter.

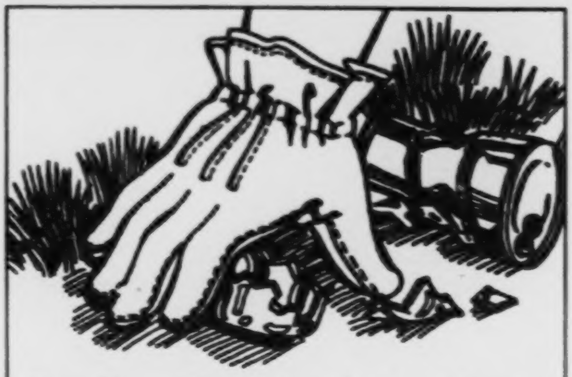
Learning Procedure

1. Review with the class the sources of litter covered in the Background section of this lesson. You may also want to bring in examples of different types of litter, identifying the location where the litter was found. **Ask:** What is litter? *(Litter is waste out of place)* Why is there litter? *(People cause litter)* Where might you find litter? *(Where people work and play)* How can you and your family help prevent litter? *(Put your trash in a trash can and keep the lid on tight. Pick up litter you see and put it in the trash can.)*

2. Have the children save their lunch sacks or bring grocery sacks from home. Take the children for a walk around the playground and the neighborhood, picking up human-made litter.

On returning to the classroom, have the children empty their litter collections onto sheets of old newspaper. Have each child talk about where litter was found. **Ask:** What might have caused litter in that place? Why? How? Make a list of responses on the board. Have the children sort and count the litter according to types of material. Can it be reused or recycled? **Ask:** How many items are recyclable or reusable? Circle the name of the item that can be reused or recycled. **Ask:** Are there more reusable and recyclable items than items for disposal?

3. Have the children make a list of who, besides themselves, can prevent litter in their neighborhoods and school. They may want to make a map of the neighborhood, including the school grounds, indicating where the litter receptacles are located. After discussion, they could indicate on their maps where they think litter receptacles *should be* located.



Note: Have children wear gloves and instruct them not to pick up any sharp objects. If they find something like this, have them call you over. You may want to divide the students into small groups and invite parents to come along as chaperones.

Questions for the Class

1. What is litter?
2. Who causes litter?
3. Where might you find litter?
4. How can litter be prevented?

Extension Activities

1. Hold a poster and slogan contest emphasizing litter control. Give awards for posters and slogans.

Display posters around the school. Contact the South Carolina Clean & Beautiful office about their Annual Poster Contest. They can be reached in Columbia at (803) 734-0144 or you may have a local chapter of Keep America Beautiful. Check your Yellow Pages.

2. Bring in several examples of litter and determine if they are from nature or from people. Make certain the children understand the difference between the two types of litter. Perform this simple experiment to see what happens over time to nature's litter and what happens over time to the litter people generate:

Take two jars, or any type of container such as a plastic egg carton, and place samples of nature's litter in one and people litter in the other. Combine with soil. Be sure to lightly water each. Observe what happens to the contents of both containers over a week's time. (Keep containers open to air and light.) **Ask:** What is the best thing to do with each type of litter?

3. Read *Litterbugs Come in Every Size* by Nora Smaridge, Golden Press, Wisconsin, 1972.

4. Have students read *The Wartville Wizard* by Don Madden, the story of a man given the power to make litter fly back to the person who threw it down.

6. Enjoy these litter projects:

- Drama - Have students select a piece of litter. Use it to act out a scene telling who owned it, what was it used for, and how did it become litter. Start with the components of the object and trace its history up to the point at which the article is discarded.
- Creative writing - Do the same assignment in written form.
- Art - Draw a picture story about litter.

Just Do It

Have the class adopt a portion of the playground or school grounds to police for litter on a regular basis.
If your school does not have enough trash cans, have students organize a campaign to get them.

Action for a cleaner tomorrow.

A South Carolina Environmental Curriculum

For more information about South Carolina and the environment, call the
South Carolina Department of Health and Environmental Control at
1-800-768-7348.

Garbage Snooping

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 2 - 3
Focus: Home waste stream
Subject: Social Studies, Science, Language Arts
Materials: Garbage survey, detective badges, note to parents
Teaching Time: 60 minutes, excluding home garbage study
Vocabulary: Landfill, waste stream, disposal, incinerator

Learning Objective

Students will:

- define waste and consider the implications of throwing something away
- analyze their family's waste stream
- discuss ways of reducing waste.

Background

We all produce a lot of garbage but are often unaware of what happens to this waste. We all have a responsibility for waste management.

In South Carolina, we throw away about 5.6 pounds of household trash every day. This household trash includes food waste, yard waste, packaging and other items we chose to throw away.

South Carolina recently passed the Solid Waste Policy and Management Act that seeks to regulate the **disposal** of trash across the state … from homes, offices, cities, and towns. (See information on the State Solid Waste Management Plan in the Resource section of this curriculum.)

Learning Procedure

1. Tell students that the governor and lawmakers of South Carolina recently passed the Solid Waste Policy and Management Act that sets goals for reducing the amount of trash going to our **landfills** and **incinerators**. To do this, it is essential to know what is being thrown away now so that the amount of waste removed from the **waste stream** can be measured. As a group, the class will investigate throw-away habits of the people of the community.

2. Give each student an official garbage detective badge. *(Example included)* The first thing a detective must do is to make assumptions.

3. Have the students make assumptions about the average household's garbage. What does the typical bag of garbage contain? Make a list. In what

DOWN TO EARTH

The United States National Park system is one of the best-maintained in the world. It preserves forests, mountains, lakes and natural sites.

proportion are these items found? Have students estimate and list an order. Consider the following: glass, tinned cans (actually 99 percent steel), aluminum, paper, and plastic.

4. Now it's time for the investigation. Each detective will keep a record of his/her household garbage for one week. This is how it will be done:

- Explain the investigation assignment to family members and ask for their cooperation. (See *Note to Parents* included with this lesson.) Ask family members to put all their trash in predetermined collection areas to help make the job easier.

- At the end of each day, empty the contents of the waste containers onto a large sheet of plastic … in the garage or yard for mess control.

- Wearing gloves, separate the garbage into categories: plastic, glass, paper, food, tinned items, aluminum, other. Then count and/or weigh, if a scale is available, each category. Keep a record on the chart provided. *Take special care when handling cans, glass, etc.* If recycling is being done, keep a separate chart for these items.

- Be sure to return all trash and recyclable items to appropriate areas.

5. After a week, the detectives will write a summary of their research and present their findings to the class.

Option: This exercise can be quite messy and requires parental supervision and cooperation. You may find that is is more practical to perform this as a group activity in which the teacher supplies the trash for the students to sort and measure.

Questions for the Class

1. What kinds of things did your family throw away?

2. Were you surprised at the amount that was thrown away? Explain.

3. How did your findings compare to others in the class?

4. Were items thrown away that could have been reused or recycled?

Extension Activities

1. The records of family garbage kept by students can be used as an evaluation tool. Have students state one action that may be taken to reduce the family's waste stream, practice this action, and repeat the investigation after a month to see if students have reduced their family's waste stream.

2. Have the class produce a large chart indicating what they found during their Garbage Snooping.

3. All living creatures produce some sort of waste, but their ways of disposing of it vary greatly. Humans are very wasteful compared to other creatures on earth. Often we are unconcerned with what happens to our waste and unaware of the impacts it can have on the environment. By looking at how animals and plants minimize the amount of waste they produce, as well as the ways in which they deal with their garbage, we can learn some important lessons about efficiency and waste disposal.

- Have the students research an animal of their choice to learn about its habitat, way of living, the kinds and amount of waste it produces, and its methods of dealing with this waste. The students could write and illustrate stories based on what they have learned and present them to the class.

- Or, ask each student to draw two pictures: one of their house and the other of an "animal's house." Have the students share their pictures with the class and start a discussion on where garbage fits into each picture. Do animals have garbage? Who produces more garbage, people or animals? What are some differences and similarities between waste generated by people and animals? Why do people throw away so much more than animals? How do people get rid of their garbage? Where does it go? What could people do to be more like animals regarding the production and disposal of waste?

Dear Parents,

Our class is participating in a school project about waste reduction and recycling. We will learn how to recycle and reuse materials and reduce the waste that is thrown away. For this project, your child will determine what your family throws away and will consider ways to reduce the amount of garbage you produce.

Please help your child be a Garbage Detective. Your child has been given the following instructions for performing this activity:
1. Ask family members to put all their trash in pre-determined collection areas to help make the job easier. For health reasons, do not include food items or yard wastes in the items collected.

2. At the end of each day, empty the contents of the waste containers onto a large sheet of plastic ... in the garage or yard for mess control.

3. Wearing gloves, separate the garbage into categories: plastic, glass, paper, food, tinned items, aluminum, other. Then count and/or weigh, if a scale is available, each category. Keep a record on the chart provided. Take special care when handling cans, glass, etc. If recycling is being done, keep a separate chart for these items.

4. Be sure to return all trash and recyclable items to appropriate areas.

After a week, the detectives will write a summary of their research and present their findings to the class. Recycling some of what we otherwise throw away is an easy habit to form. By finding out what materials can be recycled in our community and changing some buying habits, your family can help reduce waste in South Carolina.

We hope you will encourage your child by making this a family project. And thanks for reducing, reusing, and recycling!

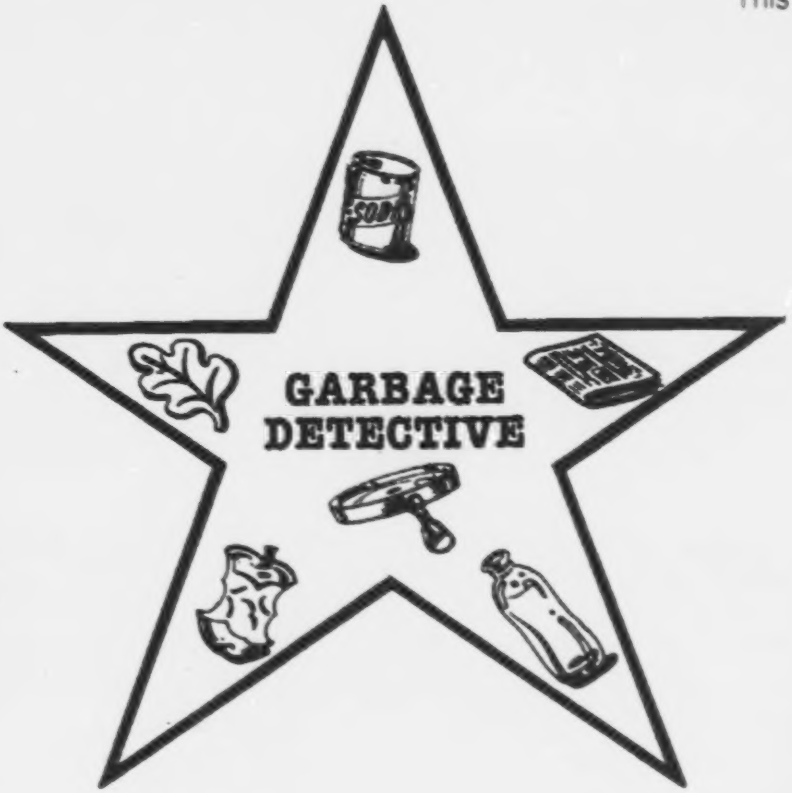
GARBAGE DETECTIVE
SODA

Here's What I Found Snooping Through The Garbage.

Days of the week	Aluminum	Scrap Paper	Newspaper	Glass	Tinned Cans	Plastic	Is it Recyclable or Reusable

Just Do It

Ask the local newspaper and/or radio station if the class can present one idea per week on how people can reduce their waste stream.
This could become a very influential public service.


GARBAGE
DETECTIVE
SODA

GARBAGE
DETECTIVE
SODA

Action for a cleaner tomorrow.

A South Carolina Environmental Curriculum

For more information about South Carolina and the environment, call the
South Carolina Department of Health and Environmental Control at
1-800-768-7348.

What's Hazardous

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 2 - 3
Focus: Household hazardous waste
Subject: Health, Social Studies, Science
Materials: See list of materials itemized below
Teaching Time: One class period
Vocabulary: Toxic, poison, household hazardous substances

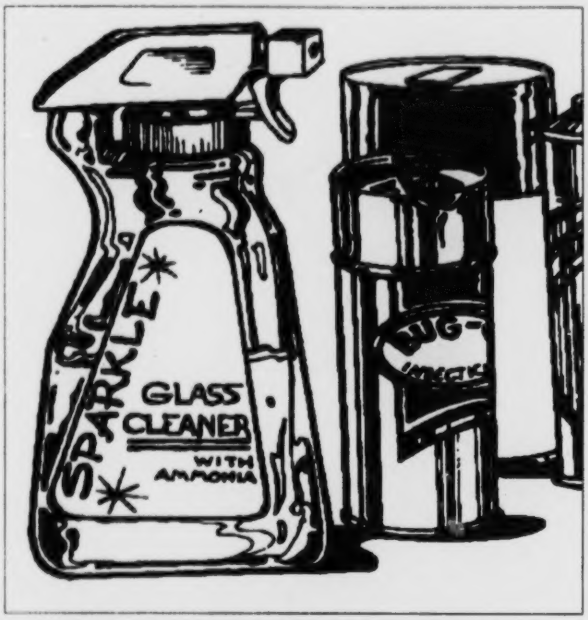
Learning Objective

Students will:

- learn many household products are hazardous in the home and after disposal
- understand household hazardous products must be carefully separated from regular waste
- be able to define household hazardous waste, poison, and toxic
- identify examples of these products and places they may be found.

Background

Almost every home in the United States contains a number of hazardous chemicals stored in its garage, basement, bathrooms and kitchens. Oven and drain cleaners; auto cleaners and lubricants; paints, thinners, strippers, and varnishes; bathroom cleaners; metal cleaners and polishes; pesticides; and gasoline are just some of the hazardous substances estimated to amount to between three and 10 gallons in the average home. These products may be poisonous, flammable, and corrosive and if not disposed of properly, they may injure people or pets or contaminate groundwater, which supplies drinking water. (For more information on household hazardous substances, see the Resource section.)



Almost every home contains a number of hazardous chemicals stored in its garage, basement, bathrooms and kitchens.

Materials Needed

Pictures of common **household hazardous products** (could use housekeeping magazines), Mr. Yuk stickers (can be obtained from local Poison Control Center or you may have students create their own stickers), examples of hazardous material containers (empty, clean containers), the attached parent letter, and copies of *Hazardous Word Search*.

DOWN TO EARTH

Dutch farmers are among the most intense users of chemical fertilizers in the world.
As a result, the groundwater is increasingly contaminated.

Source: 1993 Environmental Almanac

Learning Procedure

1. Discuss the meaning of the words ***poison, toxic*** and ***hazardous.*** Explain that many of the products we use every day are toxic and must be used and disposed of carefully.

2. Display different examples of household hazardous materials and explain why they are potential problems. Ask the students to identify some places around the home these products might be stored. Pictures or labels of rooms in a house posted on a bulletin board will help students. (For safety reasons, you may choose to use pictures of hazardous products rather than the items. If you do use actual containers, please bring empty, clean containers that have protective lids.)

3. Students can make collages of household products from pictures found in housekeeping magazines. Be sure they include some hazardous products and have them paste Mr. Yuk or other warning stickers over the hazardous products.

4. Share with students information about safe alternatives to household hazardous products.

5. Have students take the included handout home to their families and report to the class about their discussion with their parents.

6. Have students test their knowledge with the included *Hazardous Word Search.*

Special Note to Teachers

Take a survey of classroom art supplies to make sure there isn't anything dangerous. Obtain a list of "*Products Authorized to bear the CP (Certified Products) Seal, the AP, (Approved Product) Seal, and the HL/NT (Health Label/Non-Toxic) Seal of the Art and Craft Materials Institute, Inc.*" This is available from the Art and Craft Materials Institute, Inc.
715 Boylston Street, Boston Mass 02116
(617) 266-6800. These products are certified in a program of toxicological evaluation by a medical expert to contain no materials in sufficient quantities to cause acute or chronic health problems.

Safer Substitutes
for some
Household Products

Ammonia-based cleaners ...
Substitute: Baking soda; vinegar and salt

Bleach ...
Substitute: Borax; non-chlorine bleach; lemon juice

Drain cleaners ...
Substitute: Plunger; plumber's snake; boiling saltwater

Spot remover ...
Substitute: Club soda

Window cleaners ...
Substitute: Water or vinegar and wipe with newspaper or linen towel

Just Do It

Keep hazardous products where **they belong!**
See that your house is safe from dangerous chemicals.

Name: **Date:**

Dear Family,
Today we learned that many of the products we use every day at home contain things that can make our water, earth, and soil dirty and could make us and other living things sick.

Did you know that toilet bowl cleaner, furniture polish, flea powders, moth balls, drain openers, paints and varnishes, automobile oil and antifreeze, rug cleaners, rat poison, room deodorizers, oven cleaners, car and toy batteries, bug and weed killers and even scouring powders and window cleaners can all be dangerous? If we leave some of these where small children can reach them, children might get poisoned or burned. And if we throw them away improperly, they might hurt trash handlers or poison our environment.

For many years we didn't understand that these products might be dangerous. Many of our old landfills contain these poisons, and they pose a risk to our soil, water and air.

There are things we can do at home to help keep this from happening. Let's be careful to read labels and store, handle and use these products safely, the way they were meant to be used and stored. We can also use fewer toxic products and more non-toxic alternatives. That's the best way to help keep our environment clean.

Please help me protect the Earth.

It's the Hazardous Word Search!

Hidden below are the names of 24 hazardous items found around many households. Look for them here, but if you find them at home … Look Out! They are *dangerous*.

Don't forget to put a ✔ in the ☐ when you've found the word. Good Luck.

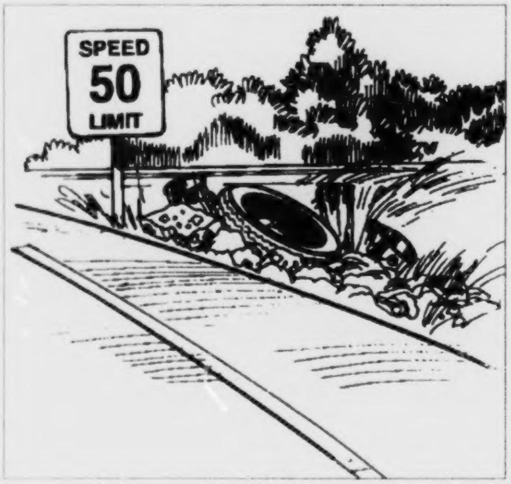
O	N	W	M	F	L	O	O	R	P	O	L	I	S	H	L	K	J	I	R
P	R	O	S	T	W	C	G	A	R	S	E	N	I	L	O	S	A	G	E
S	U	O	T	O	I	L	E	T	C	L	E	A	N	E	R	T	U	H	N
L	V	D	B	F	A	D	Q	P	P	C	A	O	U	E	E	W	A	V	A
U	A	P	D	R	A	I	N	O	P	E	N	E	R	U	A	E	I	A	E
G	D	R	E	U	N	P	A	I	N	T	T	H	I	N	N	E	R	R	L
B	O	E	M	A	J	O	D	S	H	I	S	E	L	I	I	D	O	N	C
A	O	S	H	I	L	W	E	O	O	B	T	I	A	E	O	K	U	I	W
I	I	E	K	E	F	D	G	N	J	B	A	T	T	E	R	I	E	S	O
T	L	R	Q	Z	A	E	O	N	M	S	I	L	K	J	I	L	H	H	D
Q	B	V	Z	E	A	R	F	B	L	C	N	D	E	F	G	L	R	G	N
R	A	A	Y	E	J	E	O	L	A	C	Q	U	E	R	I	E	H	F	I
S	S	T	X	R	K	D	A	A	E	L	M	N	R	T	E	R	Q	E	W
T	E	I	W	F	R	B	A	B	C	A	C	D	E	I	F	G	R	D	N
U	D	V	V	I	H	L	Z	Y	C	H	C	W	R	V	U	T	S	C	A
S	P	E	T	T	U	E	V	W	X	Y	S	O	A	P	N	A	B	Z	E
R	A	S	O	N	Q	A	P	O	N	M	D	P	L	L	L	Y	E	Y	I
G	I	M	B	A	C	C	D	E	F	O	G	N	R	L	I	J	K	X	A
J	N	K	L	M	N	H	O	P	E	Q	R	S	T	A	A	U	V	M	L
I	T	H	G	F	E	D	C	D	N	O	S	I	O	P	Y	R	B	T	E

☐ Slug Bait
☐ Paint Thinner
☐ Powdered Bleach
☐ Mothballs
☐ Varnish
☐ Batteries
☐ Stain
☐ Weed Killer
☐ Poison
☐ Floor Polish
☐ Window Cleaner
☐ Antifreeze
☐ Roach Spray
☐ Flea Collar
☐ Oil Based Paint
☐ Wood Preservatives
☐ Deodorizer
☐ Lacquer
☐ Soap
☐ Drain Opener
☐ Toilet Cleaner
☐ Gasoline
☐ Lye

Taking Trash Where?

Preparation Time: Easy To Do **Moderate** Extensive

Grade: 2 – 3
Focus: Trash disposal
Subject: Social Studies, Language Arts, Science, Art
Materials: Large roll of butcher paper, crayons, markers, glue, scissors, magazines (optional)
Teaching Time: Three class periods
Vocabulary: Trash, garbage, trash hauler, sanitary landfill, open dump



Learning Objective

Students will:

- recognize the importance of taking trash away
- learn where their trash goes.

Background

For more information on different disposal methods in South Carolina, see the Resource section.

Many students know that household garbage is either picked up from their homes by **trash haulers** each week or their parents take it to the local roadside containers, sometimes called "greenboxes." **Garbage** is the name generally used for household solid waste. **Trash** consists of material considered worthless, unnecessary, or offensive that is usually thrown away.

Once garbage and trash was taken to large open dumps. Open dumps are a waste management strategy of the past. Open dumps have been replaced by state-permitted sanitary landfills operated by trained technicians who use bulldozers to compact each day's trash and cover it with a layer of dirt. The dirt helps control rodents and odors, and prevents fires.

Some of the differences between an open dump and a sanitary landfill are: a **dump** is an open pile of trash and garbage that pollutes soil, air and water; a **sanitary landfill** is lined and covered to prevent pollution. A sanitary landfill is equipped with pipes that carry off liquids which come from the garbage when it rains; a dump is not. Garbage is covered over with dirt in a sanitary landfill, whereas a dump exposes its garbage to the open air, inviting pests and releasing odors.

The difference between an open dump and an illegal dump is that, before regulations made it illegal, an open dump was a community's landfill where trash and garbage were disposed by agreement. Illegal dumps are sites of open dumping by individuals without regard to the health and safety of others. Roadside dumping and littering are common forms of illegal dumping.

Each South Carolinian produces about 5.6 pounds of household trash and garbage each day. In most areas of our state, this trash goes to a landfill or an incinerator. Many landfills are almost full and new

DOWN TO EARTH

The countries that produce the most municipal solid waste per capita are Australia, New Zealand, France, Canada and the United States.

Source: 1993 Environmental Almanac

ones need to be built. They take up valuable land, and it seems, no one wants to live near one. This is known as the NIMBY (Not In My Back Yard) syndrome.

Activities such as recycling, reusing, reducing, and composting reduce the amount of trash and garbage that must be landfilled or incinerated. While these activities will never eliminate the need for landfills, aggressively reducing the amount of garbage flowing into landfills will extend the life of existing landfills and reduce the frequency of building new landfills.

Learning Procedure

1. Review the material on garbage in the Background portion of this lesson with the students. See the Resource Section for more information.

2. Invite the school custodian to talk to the class and ask about trash removing duties: How much of the day is devoted to removing trash? Where does the trash go? How often is it picked up? What is most of the trash composed of? How much do we throw out each week? What does it cost to throw it out?

3. Arrange a short interview with the school's trash hauler for the next time they are scheduled for a pick up. When the trash truck comes, have the class watch the removal process. Then ask the trash collector about the business: When do you start working in the morning and finish at night? How many truck loads of trash do you collect each day? Why is your truck designed the way it is and how does it work? How many schools, houses, businesses do you collect from? How many miles do you drive each day? Do you ever pick up recyclables separately? Why or why not? Where do you take the trash? What happens to it then?

(OPTIONS FOR STEPS 2 & 3: If scheduling a custodian or waste hauler proves to be inconvenient, you may want to interview them yourself outside of class and role-play the parts with the class.)

4. On the basis of the interviews, have the class construct a mural depicting all the stages in creation, collection and disposal of waste. Add specific facts learned in the interview and display the mural in the school to teach others. See sample of the art included to help students construct the mural.

Questions for the Class

1. Why are custodians and trash haulers important?
2. Where does the trash go?
3. What happens to it after it gets there?

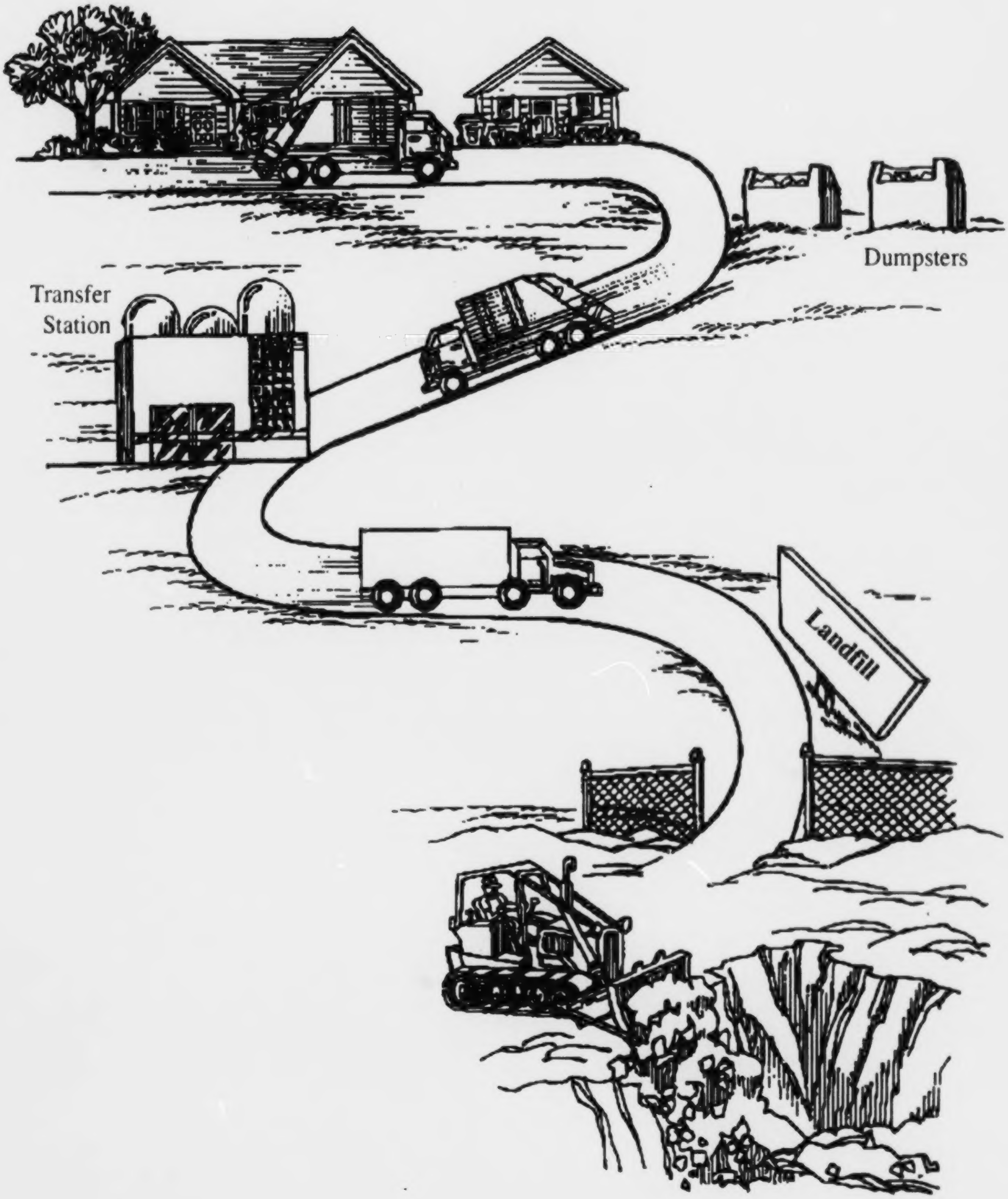
Extension Activities

1. Take a trip to the local landfill.
2. Have students conduct similar surveys/interviews with the kitchen staff at school and at home.
3. Determine how much recyclable and/or organic waste the school produces each year and devise a recycling or composting program.

Just Do It

Do your part at home. Take out the trash and the garbage from all around the house and see that it gets put in the proper place for disposal. If there is a recycling program in your community, make sure your family participates. If there is not, write a letter to your mayor or county council. Tell them that protecting the earth today is important for tomorrow. Ask them to start a recycling program.

Taking Trash Where?


Dumpsters
Transfer Station
Landfill

Action for a cleaner tomorrow.

A South Carolina Environmental Curriculum

For more information about South Carolina and the environment, call the
South Carolina Department of Health and Environmental Control at
1-800-768-7348.

Mining the Landfill

Preparation Time: **Easy-To-Do** Moderate Extensive

Grade: 2 - 3
Focus: Keeping resources out of the landfill
Subject: Social Studies, Language Arts
Materials: *Mining the Landfill* word search
Teaching Time: 45 minutes
Vocabulary: Recycle, reuse, landfill, resources

Learning Objective

Students will:

- define a landfill
- see alternatives to landfilling valuable resources.

Background

Landfills are enormous holes in the ground where garbage is buried. A majority of our trash is buried in sanitary landfills, specially designed areas that are lined and covered to prevent landfilled waste from harming the environment. South Carolina has 39 municipal solid waste landfills.

What's in our landfills? Well along with the trash, a lot of items are sent to the landfill that could be recycled or reused. These items contain valuable resources that can be reprocessed and used again.

South Carolina's goals are to reduce the volume of waste going to the landfill by nearly one-third and to recycle at least 25 percent (one-fourth) of its trash. For more information on landfills in South Carolina, see the Resource section.

These goals can be met with everyone's participation. Even if recycling for all items is not available in your area, you can help South Carolina meet its goals by reusing and composting.

In South Carolina, our garbage is:

- 37.6 percent paper (much of which is reusable and recyclable)
- 15.9 percent yard wastes (should be composted, banned from landfills in South Carolina)
- 15.6 percent other, such as clothing (much of which can be donated and reused) and wood
- 8.3 percent metals (such as recyclable aluminum and steel cans)
- 9.3 percent plastic (some of which is recyclable such as soda bottles and milk jugs and some can be reused)
- 6.7 percent food waste (some of which can be composted)
- 6.6 percent glass (virtually 100 percent recyclable).

Note: you might want to round these numbers and create a classroom pie chart showing the make-up of our waste stream.

Learning Procedure

1. Give students the opportunity to save items from the landfill in the *Mining the Landfill* word search puzzle.

2. Discuss how these items can be removed from their household or classroom trash before they go the the landfill. (If you throw valuable resources – paper, glass, plastic, or aluminum – away, they end up in the landfill forever. Items that can be reused or recycled do not belong in the landfill! Are there disposal alternatives other than landfills *(recycling, reuse, repair, incinerators, composting.)*

DOWN TO EARTH

According to a study by Newsday, the Fresh Kills Landfill in New York may soon be the highest point on the Eastern Seaboard south of Maine.

Mining the Landfill

Help! Some very valuable things are on their way to the landfill.
Save them from being thrown away. Circle in blue, the things that can be recycled.
Circle in green, things you could reuse. Some items may be both!

Be sure to look for:

Newspaper
cardboard
bottles
milk jugs
old toys
brush

tin cans
jars
grocery bags
margarine tub
box
motor oil

plastic bags
crayons
pencils
blank paper
art paper
aluminum plates

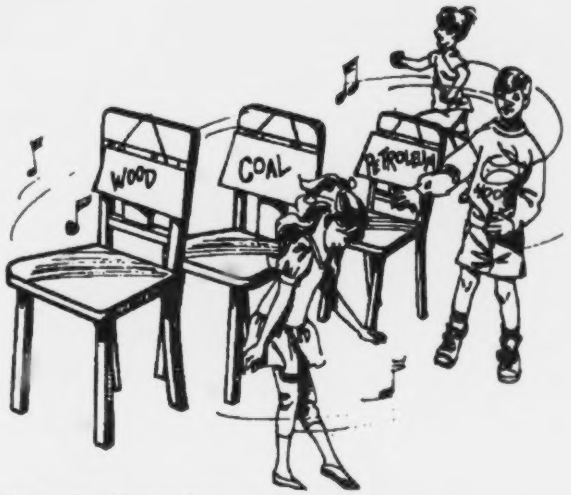
Also look for hidden bonus words!

S	A	V	E	Y	A	R	E	D	U	C	E	L	M	N	O	P
V	W	X	Y	Z	L	R	E	P	A	P	•	K	N	A	L	B
G	H	I	T	B	U	T	E	N	I	R	A	G	R	A	M	J
F	T	X	I	P	M	I	L	K	•	J	U	G	S	Q	R	S
L	P	E	N	C	I	L	S	O	L	D	•	T	O	Y	S	K
U	N	E	•	V	N	R	E	U	S	E	I	C	•	M	D	•
N	I	T	C	M	U	S	A	V	E	C	R	A	Y	O	N	S
C	E	B	A	C	M	A	B	C	•	N	Q	R	S	T	U	R
H	A	W	N	U	•	P	Q	B	R	O	M	D	R	O	R	E
•	R	R	S	Z	P	Y	A	R	E	L	X	B	L	R	A	C
B	T	E	L	P	L	G	M	U	D	I	B	O	X	•	B	Y
A	•	U	Z	J	A	R	S	S	U	T	O	A	K	O	R	C
G	P	S	K	R	T	P	K	H	C	T	T	R	D	I	J	L
S	A	E	L	M	E	P	E	R	E	E	T	D	M	L	K	E
O	P	X	Y	Z	S	O	P	R	Q	R	L	D	O	N	T	M
R	E	C	Y	C	L	E	B	C	S	P	E	W	A	S	T	E
G	R	O	C	E	R	Y	•	B	A	G	S	X	E	K	O	J

Musical Resources

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 2 - 3
Focus: Dwindling natural resources
Subject: Science, Language Arts, Physical Education, Music
Materials: Chairs equal to half the number of students, 20 assorted objects (see list in Procedures below), index cards, crayons, music and player, a bag
Teaching Time: One class period
Vocabulary: Renewable, nonrenewable, raw material, consumption, finite, natural resources



Learning Objective
Students will:

- identify natural resources
- see how natural resources are used by the things we buy and use each day.

Background
Many of our natural resources are truly finite, that is, they are limited in number. It is important to reduce our use of these resources to make them last. Good ways to conserve resources are to reduce what you buy, reuse what you can, and recycle as much as possible.

This activity is similar to Musical Chairs. Chairs represent natural resources and, as they are depleted, chairs are removed; however, everyone remains in the game and more people are added to simulate the growing population. The students must share chairs to demonstrate increasing stress on our diminishing supply of resources.

Learning Procedure
1. Arrange the chairs (chairs equal to half the number of students) to fill a large circular area representing the earth. (To start the game, there will be a chair for each *beginning* player.)

2. Tape to each chair an index card with the name of a resource on it. See the sample cards included with this lesson. Some resources may have to be used more than once.

3. Tell the students they represent the people of the world and the chairs represent the resources of the earth.

4. Place 20 objects in a bag. *(Soda can, aluminum foil, perfume, plastic bag, paper sack, drinking straw, comb, pencil, bottle, paper clip, ruler, etc. Select items that represent a wide variety of natural resources.)*

5. Have half of the students sit in the circle of chairs. Have each student choose an item from the

DOWN TO EARTH

North America has 8 percent of the world's population, but it uses 39 percent of the natural resources used annually.

bag representing resources. The other half of the class should also participate in the discussions.

6. Going around the circle, ask each student to name the **natural resource** and/or **raw material** used to produce it. (NOTE: The students may need help with naming the basic raw materials used. For example, plastic is made from oil or petroleum, a nonrenewable resource.)

7. Make a list of the natural resources the students name. Discuss whether they are **renewable** and **nonrenewable.**

8. Tell students sitting in the chairs that they are the people of today's world (the players) and the other half of the class are the future people of the world (they will sit out and watch until they are "born" and called upon to play). Give each student in both groups a crayon to use later in the game.

9. When the music plays, the people will walk around the circle, similar to Musical Chairs. While there are a **finite** amount of resources, there are plenty of resources for everyone at the beginning of the game. When the music stops, everyone will find a place to sit. At this time, each player is instructed to color one of the little squares on the card where he or she is sitting to represent the consumption of part of that particular resource. **Ask:** What resource are you consuming and what is it used to make?

10. When the music begins, the procedure is repeated. Again, instruct the players to find a chair (resource) and color a square when the music stops.

11. Before starting the music a third time, tell the students that there are more and more people being born every day, so add three or four new members to the world's population. Begin the music. This time when the music stops, there will not be enough chairs for each to have his or her own, so those left without one must find someone who is willing to share his or her chair. Again, each person must color a box on that chair's card. Chairs holding two people will receive two marks on the card, chairs holding three, receive three marks and so on. Everyone must be sitting before the music begins again.

12. Repeat the procedure, adding additional players with each new round. WHEN ALL THE SQUARES ON ANY ONE CARD ARE FILLED IN, THE CHAIR IS REMOVED FROM THE EARTH. *(This is to represent the* ***consumption*** *of that natural resource.)* Continue this process until nearly all the chairs are gone, and all the students are balancing several people deep on the remaining chairs.

Questions for the Class

1. What would happen if the game continued and we kept on populating the earth and consuming our resources?
2. Was it sometimes difficult finding someone to share a chair or lap? Do countries have difficulty sharing resources?
3. How did it feel to be crowded on one chair? How did you feel when a resource (chair) was removed?
4. Is there a similar problem on our Earth? Are some nations using resources more rapidly than others?
5. How could we preserve our natural resources? Make a list of ways to conserve our resources.

Extension Activity

Play musical resources again, but this time when a player reaches the chair, give the student the option of stating a way the resource can be recycled or conserved. If the player can think of a way to conserve (not consume) the resource, the boxes will not have to be filled in. The game can go on indefinitely when the resources do not have to be consumed. Remind students that even renewable resources need wise conservation.

Just Do It

Think about our natural resources when you are considering buying something. Is the item a good use of resources?

Bauxite (Aluminum)		

Resource
used to make:
Aluminum,
Aluminum
Cans,
Automobile
Parts, etc.

Copper		

Resource
used to make:
Electrical
Wiring for
homes
factories,
businesses,
cars and
computers,
etc.

Gold		

Resource
used to make:
Jewelry,
Electrical
Components,
etc.

Iron in ore (steel)

Resource
used to make:
Food Cans,
Construction
Supplies,
Magnetic
Tape such as
Cassette and
Video Tapes,
etc.

Wood

Resource
used to make:
Paper, Books,
Furniture,
Construction
Materials,
etc.

Petroleum

Resource
used to make:
Gasoline,
Plastic,
Medicines,
Polyester and
Other
Fabrics, etc.

Sand

Resource
used to make:
Glass,
Construction
Material, etc.

Cotton

Resource
used to make:
Cotton
Fabrics such
as Denim,
Rugs, Some
Papers, etc.

Feldspar

Resource
used to make:
Glass,
Insulation
Material, etc.

Tin		

Resource
used to make:
Metal Alloys,
Electronics,
etc.

Silver

Resource
used to make:
Jewelry,
Electronics,
Photographic
Films, etc.

Pick An Item, Any Item

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 2 - 3
Focus: What we buy has an effect on natural, resources
Subject: Social Studies, Language Arts
Materials: A can of oil, a piece of wood, a chunk of coal, ore sample (optional)
Teaching Time: 30 minutes
Vocabulary: Natural resources, renewable resources, nonrenewable resources

Learning Objective

Students will:

- list some of the natural resources used to produce a prized possession.

Questions for the Class

1. What are **natural resources**? List five natural resources.

2. What is the different between a **renewable** resource and a **nonrenewable** resource? Give an example of each. *(Wood, Petroleum)*

Learning Procedure

1. Define natural resources *(wood, minerals, petroleum)* and list on the board. Have students bring in a prized possession or, if the item is too large, expensive, or fragile, have students draw a picture of it. Discuss the natural resources that were used in the manufacture/production of the item. If necessary, show the students some examples of your prized possessions to help.

2. Either at home or in class, list the natural resources used in producing the favorite item.

3. Show and tell time: Have students share their favorites, listing the resources used in producing the items. **Ask:** What other resources could have been used to make your favorite possession? What will happen to your prized possession if it is broken? Is there any way it can be reused for another purpose?

4. Find examples of toys made from reused materials. *(a doll house and furniture, a match box car, etc.)*

5. Discuss the difference between renewable and nonrenewable natural resources. Identify examples of each among the items the students have brought.

Extension Activities

1. Make a game consisting of names or pictures of commonly used items and a list or picture page of commonly used natural resources. Supply the name or picture of the items and have students circle all the natural resources used in its production.

2. Discuss the qualities: fragile, short-life vs. durable, long-life. **Ask:** What are some things we buy and use for only a short time? Examine some of the short-lived items. **Ask:** What about these items could be changed to make them more durable?

3. List three items in your school or home made of nonrenewable resources; then list a substitute item for each of these that is made from a renewable resource.

DOWN TO EARTH

Although it is made of natural resources, glass is 100 percent recyclable.

Action for a cleaner tomorrow.

A South Carolina Environmental Curriculum

For more information about South Carolina and the environment, call the
South Carolina Department of Health and Environmental Control at
1-800-768-7348.

Maybe It's Not A Dream

Preparation Time: **Easy-To-Do** Moderate Extensive

Grade: 2 - 3
Focus: Environmental effects of pollution
Subject: Language Arts, Social Studies
Materials: *Just a Dream*, by Chris Van Allsburg
Teaching Time: One class period
Vocabulary: Environment, pollution, smog, future

Learning Objective

Students will:

- describe the long-term effects of pollution on the environment.

Background

Since man first built a fire, people have sought to make their lives more comfortable and convenient. Pollution is a by-product of these advancements. Until the 1940s there were no laws or regulations to control the effects of **pollution** on our **environment**. For more information, see the Resource section.

Learning Procedure

1. Read the book *Just a Dream* to the class. Discuss the story and its illustrations. Compare what it is like now to what it may be like in the future, according to the book.

2. Pollution also affects all living things: people, plants and animals. Have the students choose people, plants or animals and write a story of how they think their choice may be affected by pollution in the future.

3. Have the students illustrate their stories and collect them into an anthology to share with parents and other students in the school.

© 1990 Chris Van Allsburg. Published by Houghton Mifflin Co.

Extension Activities

1. Have the students interview their parents and grandparents and write a report about how the environment has changed in their lifetime.

2. Compare their answers to the picture of the future described in *Just a Dream*.

Just Do It

As a class, plant a tree on the school grounds. On a plaque near the tree dedicate it to the second or third grade 25 years in the future. Take a picture of the class with the tree and keep it in the school archives.

Ask your parents to help you plant a tree in your yard at home.

DOWN TO EARTH

In 1991, the United States' major parks — the Grand Canyon, Acadia, Great Smokey Mountains, Yosemite, Mount Ranier and the National Mall in Washington, D.C. — recycled more than 220 tons of plastic, glass, aluminum and other products from the garbage left behind by visitors.

Action for a cleaner tomorrow.

A South Carolina Environmental Curriculum

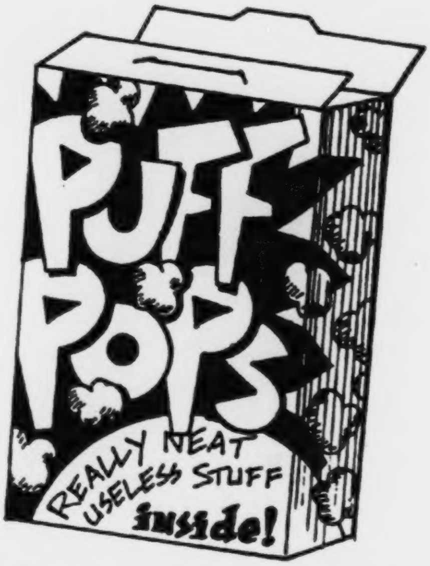
For more information about South Carolina and the environment, call the
South Carolina Department of Health and Environmental Control at
1-800-768-7348.

2.IV.1.F

Ads Add Up

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 2 – 3
Focus: Waste reduction and packaging
Subject: Language Arts, Art, Social Studies, Math
Materials: Magazine ads, ads that students bring to class
Teaching Time: 30 minutes
Vocabulary: Waste reduction, consumer, consequences, advertising



Learning Objective

Students will:

- identify advertising
- identify good and bad aspects of specific advertisements.

Background

Nearly $1 out of every $11 spent for food and beverages in the United States pays for packaging. That is, it pays for the wrappers, boxes and papers surrounding our food. For more information on packaging and waste reduction, see the Resource Section.

What we buy is influenced by what we see on television, read in magazines and hear on the radio. In making buying decisions, we need to consider the **consequences** of our buying choices. What happens to what we buy when we no longer want or need it?

Learning Procedure

The day before sharing this lesson with the class, send notes home to parents asking their help in having students bring in an advertisement for something that appeals to the child, something that the student would like to buy. For homework, have students write why they like the ad they have chosen.

1. Show a magazine ad that would appeal to second and third graders. Kids enjoying a product, for example.

2. **Ask:** What are the people in this ad doing? Would you like to be one of these people? Why? or Why not? Why was this picture taken?

3. **Ask:** Have you ever wanted something because you saw it on television, bought the item and were disappointed with it because it didn't measure up to the **advertising** promises? How does advertising try to influence your thinking?

4. Have students share and evaluate the ads they have brought to class. **Ask:** What's good about the ad? Do they have the product or know someone

DOWN TO EARTH

In Germany, a Green Dot recycling symbol on a package means that the product's packaging will be collected for recycling. Households have special bins for Green Dot items that are collected each month.

who does? Does the ad present the product fairly? Does the product live up to its advertising?

Questions for the Class

1. What does **"consumer"** mean? *(People who buy things.)*
2. Where does packaging go if you throw it away? *(Buried in the landfill or burned in the incinerator.)*
3. How can you reduce the amount of packaging in your garbage can? *(Buy items with less packaging, recycle packaging, buy packaging that can be reused.)*
4. What are two types of packaging that are easy to recycle? *(Know what is recyclable in your area.)*

Extension Activities

1. Create an ad that encourages people to buy a product that lasts.

2. When we choose what we buy, we also choose the waste created in the manufacturing process and the packaging that goes with it. People can learn to purchase products to avoid waste; this is called **waste reduction**. In this activity, students will identify excess packaging and will offer alternatives that are healthier for the environment.

Offer students a choice between two identical products: one with an "attractive" package and the other without packaging (such as a plain apple and an apple with a pretty bow.)

Ask the students which apple they would prefer. *(It is highly likely the apple with the bow will be chosen.)* Discuss briefly the power of packaging:

- Why did you choose the one you did?
- Which one would sell better in the supermarket and why do you think so?
- Although the bow helps sell the apple, does it add anything to the apple?
- Which apple has more waste?

Describe or display some products that have appealing packages (cereal boxes, snack cakes, beverage containers, etc.).

- What makes these appealing? *(colorful, "big" names, offers of prizes, trends, etc.)* Make a list.
- What is the purpose of packaging? Make a list of reasons for packaging. *(protection from breakage, sanitation, food preservation, uniformity for display, shoplifting prevention, etc. Some packaging is necessary to keep a product — such as medicines — fresh, safe or "contained."*
- Are products in generic packages as good as products in "name brand" packages?

3. Read and discuss the poem *How The Trash Pile Grows*. Do you think this is what we should do? Why? What does it mean by, "Oh, no - where is 'away' "?

How the Trash Pile Grows

Buy it, try it, throw the trash away!

Take it, break it, throw the trash away!

Get it, use it, finish it, lose it. Wear it, tear it,
throw the trash away!

Soda pop, box top, once you start you can't
stop. Buy it, show it, nothing left but throw it:

Throw the trash away!

(Oh, no — where is "away"?)

5. As a math exercise, have students bring in their family's receipts for one week. Add them up and figure out how much they paid for packaging. *($1 out of every $11 spent for food and beverages pays for packaging.)*

Just Do It

Look for examples of products that are overpackaged and make a list of those products. Design a better package for one of them and send your suggestions to the manufacturer or company, politely encouraging them to consider your ideas.

It's In The Bag

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 2 – 3
Focus: Reuse
Subject: Social Studies
Materials: Bags made of brown paper, white paper with handles, plastic, cloth, mesh or net; and a cardboard box
Teaching Time: One class period
Vocabulary: Energy, reuse

Learning Objective

Students will:

- compare optional containers suitable for carrying groceries home from the store
- describe how energy and natural resources would be saved in a year by using your own reusable grocery bag.

Background

Manufacturing food containers and packaging – including grocery bags – consumes energy. Once empty, packaging is a big part of our solid waste. Almost half of all household trash is packaging. For more information on packaging, see the Resource section.

Learning Procedure

For this lesson, it is effective to demonstrate the volume of bags one family might bring into the home in a single week by collecting your bags and bringing them to class for this lesson. Collect all of your bags including grocery bags; bread, potato and other food bags; lunch bags; department store bags; etc. and bring them to class.

1. Bring all of your bags to class in one single bag. Hold this bag up and pull one bag from the original bag. Tell where that bag came from and what you brought home. Drop it to the floor and pull out another bag. Tell its story and drop it to the floor. Continue this until you have amassed a large number of bags on the floor in front of the students.

Tell students that, while each bag seemed useful at the time, all of these bags seem unnecessary now. **Ask:** What could you have done to use fewer bags?

2. Discuss reasons for carrying purchases home from the store in a reusable bag. Discuss that **reusing** bags saves **energy** and natural resources *(trees, water, energy)* over manufacturing new bags. Review the attached scenario, "*No bag, please.*" Ask students to try it the next time they go to the store.

3. Discuss the practical merits of carrying groceries in the different bags you have brought to class. Discuss the typical life span of the containers. *(A brown paper bag will not last as long as a cloth bag.)* Discuss disposal of the different bags once

In the United States, plastic grocery bags have gone from 2.3 mils thick to just 0.7 mils thick, with the same durability.

they can no longer be used to carry groceries. Can you recycle a plastic grocery bag? Where? What about the paper bags? How about a box? Discuss if any of the containers are easier to use than the others. *(The bag with handles is easier to carry than the ones without, but it may not hold as much. The box will hold heavy items, but it will not store as easily as a folded bag.)*

4. Have students find out if the grocery store where they shop gives a small credit to customers who reuse grocery bags and/or if the store has a bag recycling/reuse program.

5. **Ask:** How many ways can you recycle or reuse a paper or plastic grocery bag? Challenge the class to a competition to see who can come up with the most ways, the most creative ways, etc.

Questions for the Class

1. How many bags does your family bring home in a week? In a year?

2. Have students save their bags at home and add them up by type. How many paper? How many plastic? Create a classroom graph.

Everyone knows that when you save paper, you save some trees that wouldn't have to be cut down to make new paper.

Just Do It

Talk with your parents about the different kinds of grocery bags and choose the one that's right for your family. Then ... take your own bags to the grocery store, or be sure to reuse or recycle the bags you get.

No Bag, Please

It is sometimes easier to try new ways if you can get other people to try them with you. Maybe a friend or two from school or Mom and Dad will try the "No bag, please" experiment with you.

Everyone knows this. But you can find out how hard it is to get people used to saving paper.

Try this project when you are going shopping. Take a big shopping bag with you. When you purchase something, watch carefully.

Does the person at the counter start to put your purchase in a bag for you automatically?

If this happens, say, "I don't need a bag, thanks."

Then see how the person at the store acts. Surprised? Pleased? A little bit angry? Confused?

How do you feel? Embarrassed? Ordinary? Good?

Crayon Trash Stash

Preparation Time: **Easy-To-Do** Moderate Extensive

Grade: 2 - 3
Focus: Reuse
Subject: Science, Art
Materials: Student's crayons or a large box of used crayons
Teaching Time: 30 - 45 minutes
Vocabulary: Trash, recycle, reuse, landfill

Learning Objective

The students will:

- look at ways resources are wasted
- consider alternatives to "trashing" their used, broken and worn-out items.

Background

Reusing things is an important lesson in reducing garbage. While it may seem easier to just throw things away, it can be fun to invent ways to **reuse** them.

Crayons are simple items to use in demonstrating just how easy and fun it is to reuse things that you might otherwise throw away.

Some crayons are made from the fat or tallow of hogs or cattle. This is a by-product, or a reclaimed product, from the livestock industry. Other crayons are petroleum based.

In this lesson, students will sort their crayons into two piles; perfect (in new condition) and not perfect (broken). The broken crayons will be stashed as **trash**. Students will then be given the task of creating a picture of a rainbow with only the perfect crayons remaining. The students will speculate what their pictures might have looked like if more crayon colors had been available. Other items commonly thrown away will be re-evaluated for their reuse value.

Learning Procedure

1. Distribute a handful of crayons to each student. Some crayons should be new and some should be used, worn, and broken. Ask the students to sort their crayons into two piles; New and Broken/Used.

2. Ask them to describe their most imperfect crayon. List responses on the board to be used later. Tell them that their imperfect pile of crayons is "trash," and they are to stash their trash in the landfill (inside their desks or into a sack).

3. Now, using only the "perfect" crayons, students are to create a "perfect" rainbow and sky picture. Do not let students share crayons.

DOWN TO EARTH

Parents' purchasing decisions are swayed by environmental information they get from their children.

Source: Environmental Research Associates Survey, 1992

4. Display the rainbow pictures. What problems occurred because of the limited resources? **Ask:** Did you wish you had more colors? Do you wish you had not thrown away the imperfect colors? Do we sometimes throw other things away that we think are imperfect? Name some and record a list on the board. Why do we throw things away? Make a list of reasons. Look again at their words that described the imperfect crayon. Are these some of the same words we use to describe the items that we throw away?

5. Explain that once something is thrown away and taken to the **landfill**, it usually stays there forever, but in this case, you will have the rare privilege of reclaiming the crayons from the landfill. Let students add to their pictures. Once this is done, the students will be given the opportunity to rethink how these crayons can be reused or recycled. Some ideas are to make Sun Catchers or Candles. (See Extension Activities.)

Extension Activities

1. Plan a "Trash to Treasure Fair" for the class. (Suggested categories for entries: an item recycled, an item repaired, an item reused) The rainbow pictures can be turned into advertising posters and awards can be made from "throw-away" materials. *(A visit to a thrift or second hand store would be useful.)*

2. Making Sun Catchers
You will need: used crayons, medium hand kitchen grater, wax paper, irons, pad of newspapers, brown paper sack cut open. (Ask for extra adult volunteers on this day. Perhaps they could bring their own irons.)

A. Have the students remove paper from crayons.
B. Ask an adult volunteer to grate the crayons into separate colors. This could be done ahead of time to save time. Crayon shaving can also be done using scissors.
C. The students will sprinkle crayon shavings on top of a sheet of wax paper, keeping colors separate.
D. Cover with a second sheet of wax paper, making a sandwich.
E. Prepare a pad of newspaper to protect surface from iron.
F. Cut open a brown paper sack and lay on top of newspaper for a blotter.
G. Put the wax paper sandwich on brown paper and newspaper pad.
H. Cover sandwich with another piece of brown paper.
I. Using a medium hot iron, melt the two layers of wax paper together. This will also melt the crayons, creating a stained glass effect.
J. After cooling, cut the Sun Catcher into a shape *(butterfly, fish, flower, etc.)* either by tracing a shape first or by cutting freehand. *(A mobile of many shapes can be made or they may be hung in a window.)*

3. Making a Crayon Candle
You will need: candle wax, used crayons, candlewicks, pencil, baby food jar, soup-size tin cans, pot holders, electric frying pan.

A. Clean and dry baby food jars.
B. Using a four-inch piece of candlewick, tie the wick in the middle of a pencil. Rest the pencil across the jar opening with the candlewick hanging inside the jar.
C. Students are to remove paper from crayons and sort by colors into tin cans. Add candle wax to each color to fill the can one-half full.
D. Set cans in the electric frying pan on low to medium heat. When melted, pour a 1/2- to 3/4-inch layer of color in each jar.
E. Let cool until set enough so that a layer of another color can be poured on top. Continue to layer the colors until the jar is full.
F. After candle is completely cooled, students can trim candlewick to 1/2- to 1/4-inch.
G. Prepare a tag stating that this gift was made from reused glass and recycled crayons and tie it around the candle. This is a nice gift for Mother's Day.

My Bag

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 2 – 3

Focus: Recycling

Subject: Science, Math, Language Arts

Materials: 4.5 lbs. of clean, selected trash (include items that can be recycled, reused and/or repaired. Also have items that can only go to the landfill), four clean plastic or paper bags, scale (kitchen or bath)

Teaching Time: 30 – 45 minutes

Vocabulary: Recycling, trash, reduce, reuse, estimate

Learning Objective

Students will:

- identify trash as recyclable, reusable, or repairable
- demonstrate the principle of reduction.

Background

Each person (including students) generates about 5.6 pounds of household trash each day. Through recycling or reusing, much of this trash can be removed from the waste stream and not disposed of in our landfills or incinerators. In this activity, students look into a typical bag of household trash and decide which items can be recycled, reused, or repaired and which ones must be thrown away. For more information on the makeup of South Carolina's waste stream, see the Resource section.

Learning Procedures

1. Show the students the bag of **trash** you have prepared and ask them to **estimate** its weight. Call on several students to estimate from just looking at the bag and then from holding the bag. Weigh the bag. (If using a bath scale, show students how to weigh the person with the trash bag, weigh the person without the trash bag, and then subtract to obtain the weight of the trash bag. Your answer should be very close to 5.6 pounds.) Tell students that this is how much trash each one of us generates each and every day. (Students may find this unbelievable. Remind them that this figure includes trash from all of their meals, classroom waste, etc. However, it does not include any of the waste from business and industry. If this was included, each person's share of the total amount of waste generated in South Carolina each day is about 8.5 pounds.)

2. Make four cards marked: recycle, reuse, repair, landfill/incinerator. Tape these cards onto the four bags. Discuss what these words mean. Find out and

DOWN TO EARTH

In 1991, more than 16,000 of the 31,000 grocery stores in the United States collected plastic bags for recycling.

discuss with the class what is recyclable in your community.

3. Have the students open the trash bag and tell what each item is used for and why it was purchased. Discuss if the product was necessary or not. Now that the item is trash, was it worth buying the product in the first place? Remind students that we can reduce the amount of trash we throw out by only buying what we really need.

4. Have students divide the contents of the trash bag into the proper categories — recycle, reuse repair, and landfill/incinerate.

5. After classifying, reweigh the items in the landfill category and discuss how much trash was saved from the landfill/incinerator.

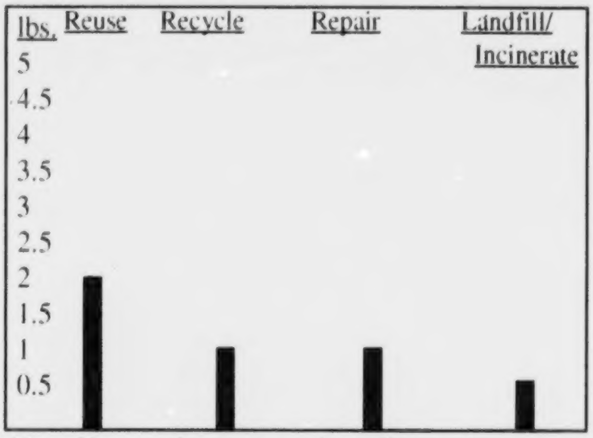
Extension Activities

1. Older children may play a recycling relay race. Divide the class into teams. Each child picks an object from a bag of mixed clean trash and delivers it to a box or bag labeled "recycle," "repair," or "reuse." Each student must justify their decision.

2. Use a bag of clean, mixed trash, hand one trash object to each student and have all students stand together in a group representing the waste stream. The teacher can be the trash collector who will take the trash away to a Sanitary Landfill, one item at a time. Tell students that, at a Sanitary Landfill, they will be put into a specially lined hole in the ground and covered with soil. They will remain there forever. It's dark, damp and there is no light or air, so … no trash decomposes. Ask if anyone really wants to go to the landfill. If they don't want to go and want to reuse the resource, have them think of a way the item can be reused or recycled. Try to save all the items in the waste stream by thinking of alternatives. Discuss ways to change the items that cannot be recycled or reused. Continue until all the students/trash items have been rescued from the landfill.

3. Have students (and teacher, too) tie a plastic bag to their waists. Each student is to place in the bag all class waste, clean and dry lunch waste, and any other waste each individual is responsible for generating. Compare the amounts at the end of the day or week. You could try this both before and after this lesson to demonstrate how the students' habits may change.

4. As a math exercise, create a chart graphing the weight of the four bags after the 5.6 pounds of trash has been sorted into recycle, repair, reuse, or landfill/incinerate.



Note: Your results may vary depending on the type of trash you select and what is recyclable in your community. There are no right or wrong answers.

5. Have students select a recyclable item and make a picture page. Have them answer the following question, write a brief paragraph, and draw a picture to illustrate. "I used to be a (NAME OF RECYCLABLE ITEM), and now I am a (NAME OF RECYCLED PRODUCT.)" For example: "I used to be a soda can and now I am a part of an airplane flying over the South Pacific."

6. Have students complete the handout *If Bagging Trash is Your Game, This Match is for You.*

Just Do It

Look before you leap.
Think before you toss.
Before you throw something away,
think if you could use it again.

Name: ______________________________

If Bagging Trash is Your Game, This Match is for You.

Match each word on the left with the phrase that best describes it.

Trash
Litter
Reuse
Natural Resources
Landfill
Recycling
Paper
Reduce
Compost

A. To find a new use for something instead of throwing it away.

B. A recyclable material made from trees.

C. To buy less and to throw away less trash.

D. Leaves and grass clippings that are broken down by natural forces and can be used on gardens.

E. Our garbage, all the things we throw away.

F. Trash that is in the wrong place, such as on the ground or in the street.

G. A process that makes something new out of something old.

H. A special place where trash is buried.

I. Things that are found in nature that we must have to live.

Action for a cleaner tomorrow.

A South Carolina Environmental Curriculum

For more information about South Carolina and the environment. call the
South Carolina Department of Health and Environmental Control at
1-800-768-7348.

Foiled Again

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 2 – 3
Focus: Recycling, Packaging and Advertising
Subject: Social Studies, Art
Materials: Healthy snacks (two kinds), bowl of sudsy water, sponge, towel, trash can, rolling pin, box, aluminum foil, string, tape, etc., various examples of aluminum cans, magnet, *Recycle Cycle* transparency
Teaching Time: Two class periods
Vocabulary: Aluminum, recycler

Learning Objective

The students will:

- predict the number of times an aluminum can could be recycled
- distinguish between aluminum, steel, and tin.

Background

Product packaging is a significant part of our solid waste stream. Much of the packaging that ends up in South Carolina's landfills can be recycled. Recycling saves landfill space, as well as energy and natural resources used to make new packaging. For more information on aluminum, packaging and South Carolina's landfills, see the Resource section.

Learning Procedure

Each student will create an aluminum foil container to fill with popcorn, raisins, or some other healthy snack. After it is used, it will be thrown into a box, representing aluminum recycling. Each student, playing the role of **recycler**, will then take a used container from the box to recycle into a new, useful product. This process will be compared to the process of recycling **aluminum**.

1. Give each student a 12-inch square of aluminum foil to form into a container for a healthy snack (raisins, popcorn, fruit, etc.).

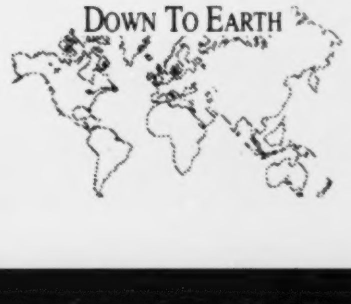
2. Have students share their designs with the class.

3. Fill each container with the snack and, as they are enjoying their snacks, talk about the kinds of containers made from aluminum. Show some examples.

4. When snacks are gone, all of the empty homemade snack containers will be tossed into a box marked "Recycle Aluminum Here."

5. Have each student select a container from the recycle box, flatten it, wash and rinse it, and reshape the aluminum into a cup to hold a second snack.

6. Ask students how many times their aluminum could be recycled. Help them compare this activity to the real process of recycling aluminum using the *Recycle Cycle* transparency.



One nation's trash is another's treasure. Bermuda, Canada, Japan, Mexico and Taiwan import used beverage cans from the United States. These nations take as much as 244 metric tons from the United States in a single month.

Source: Institute of Scrap Recycling Industries

7. Share this fact from the *Recyclers' Handbook* on the board: "Americans throw away enough aluminum every three months to rebuild our entire commercial airline fleet." Let the students, either individually or as a team, build an aluminum foil boat or airplane from their foil.

8. After the boats and planes have been properly test-piloted, make a class mobile using their crafts and some high-flying facts about aluminum and other recyclable metals.

Extension Activities

1. Research aluminum production. Write to ALCOA for information and/or pictures:

ALCOA
P.O. Box 3567
Davenport, IA 52808

2. Show the students how to tell the difference between aluminum and tinned cans. *(The typical tinned can is 99 percent steel and 1 percent tin. This type of can will be attracted by a magnet and will have a seam. Aluminum cans will not have a seam and will not be attracted by a magnet.)*

3. Bring out several magnets and a variety of cans and let students experiment and separate the cans into categories. Tell students that the raw material for aluminum is bauxite, and tin and/or iron (steel) is the raw material for "tinned" cans.

4. Set up a display of recyclable metal containers. Ask the manager of a local grocery store if your class can display this to educate and inform people about recycling.

Did You Know ...

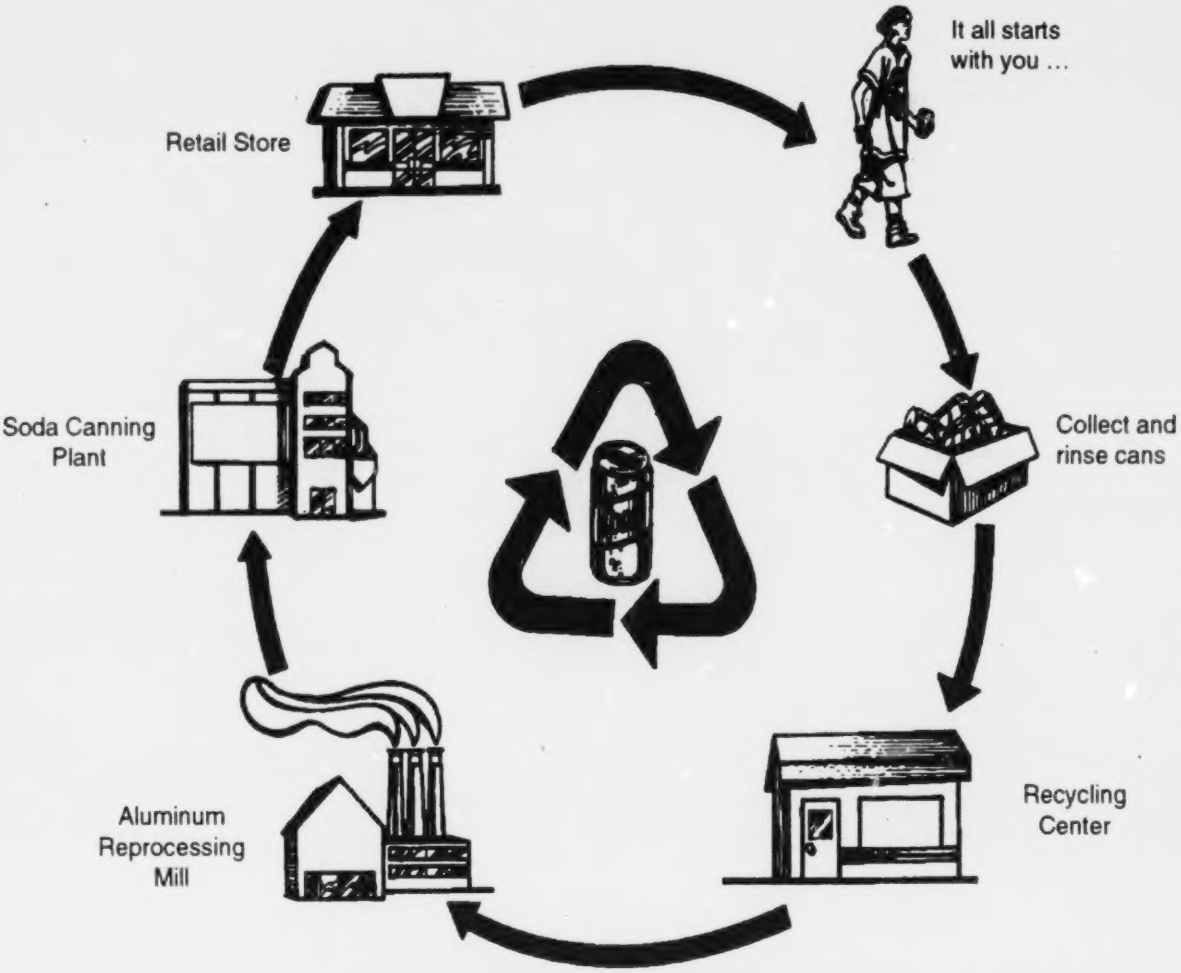
- More than one-half of all aluminum beverage cans are recycled.
- If an aluminum beverage can is thrown away, as much energy is wasted as pouring out a can half-filled with gasoline.
- In a single year, an estimated 2 million aluminum can collectors earned over $200 million by recycling.
- The aluminum can you recycle today may be back in the store as a recycled can in as little as six weeks.

Just Do It

Volunteer to rinse cans at home and prepare them for recycling. (Teachers: you may need to ask local officials about particular recycling practices, such as crushing cans and removing ends, in your community. WARNING: CHILDREN MUST BE SHOWN HOW TO DO THIS SAFELY!)

Chart a running count of the number of cans recycled by your class or team efforts and send it to a local news station or newspaper. Challenge your class and others to increase the number of cans recycled.

Recycle Cycle


It all starts with you ...
Collect and rinse cans
Recycling Center
Aluminum Reprocessing Mill
Soda Canning Plant
Retail Store

It all starts with You!

Enjoy the product ...

Rinse and place your empty can in recycle bin ...

See that items are taken to Recycling Center ...

The Recycling Center collects the cans and ships them to the aluminum mill where cans are reprocessed into useful aluminum that is made into cans or other aluminum items ...

Reprocessed cans go to the soda pop canning plant where they are filled again...

New packages of soda are delivered to the store, ready for you to buy them again!

Action for a cleaner tomorrow.

A South Carolina Environmental Curriculum

For more information about South Carolina and the environment, call the South Carolina Department of Health and Environmental Control at 1-800-768-7348.

Paper Chase

Preparation Time: Easy-To-Do [✓ **Moderate**] Extensive

Grade: 2 - 3

Focus: Recycling paper and reducing the use of paper

Subject: Language Arts, Social Studies, Art, Science, Math

Materials: Three cardboard boxes, bathroom scale, *Paper Chase* transparency/handout, *Making Paper* transparency

Teaching Time: Several days

Vocabulary: Papermaking, resource, waste, reduce, reuse, recycle, source reduction

Learning Objective

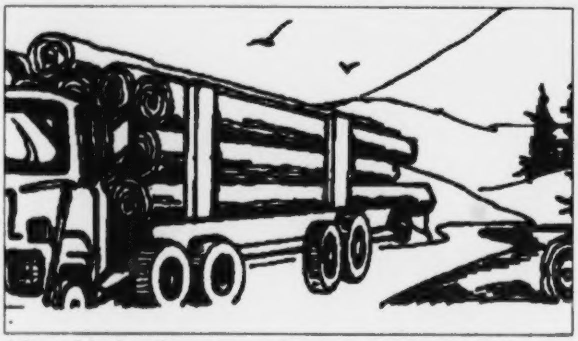
Students will:

- compute the mass of reusable classroom paper
- recall the sequence of manufacturing paper from tree fiber, including the concept that if paper is not recycled, it will be landfilled
- name three ways classroom paper can be reused.

Background

Americans "throw away" enormous amounts of paper, about 600 pounds per person each year. The largest single item of household waste is paper (about 40 percent, or 2/5, by weight).

Americans consume more paper per person than any other nation in the world. Paper products use about 35 percent (about one-third) of the world's annual commercial wood harvest, a share that would grow to 50 percent (one-half) by the year 2000, if present trends continue.



Many kinds of paper can be reused or **recycled**, particularly newspaper, computer and other office papers and classroom paper. Each ton of recycled paper saves 17 pulpwood trees. Producing recycled paper creates 74 percent (about three-quarters) less air pollution and 35 percent (about one-third) less water pollution than producing paper from virgin fibers.

The concept behind **Reuse** and **Reduce** is that, even though most paper will eventually have to be discarded or recycled, reusing paper reduces the demand for a new sheet of paper each time one is needed. This is called **source reduction**. Reusing scrap classroom paper reduces the demand for tons of new paper *(source reduction)*, saves trees *(conserving a renewable resource)* and oil *(conserving a nonrenewable resource)*, and produces no air or water pollution.

Learning Procedure

1. For one week, have students collect the classroom paper they would normally throw away into one cardboard box marked "C." *(Let the school custodial staff know what you are doing and ask them not to take this paper.)*

DOWN TO EARTH

Because they absorb carbon dioxide, trees and other greenery offer the cheapest way to combat the greenhouse effect.

Day 1

1. At the end of the week, project the *Paper Chase* transparency and distribute copies to students. Have students weigh the paper in Box C and record the weight on their *Paper Chase* worksheets in the column marked "Day 1, Box C." *(You may want to record the weight on the overhead and let students copy.)* Collect the worksheets until they are needed again. Don't discard Box C or its contents.

2. Begin a discussion of where students think paper comes from. Encourage answers that reveal the process and **resources** used in manufacturing paper, as well as the simple reply, "trees," or "store." **Ask:** Where does paper go after we are through using it? *("throw it away," trash can, dumpster, garbage truck, dump, landfill, incinerator)* Encourage any student who says "recycle" to explain what the term means.

3. Project the overhead *Making Paper*. Discuss the **papermaking** process, emphasizing the use of energy at every step of this process *(trees, logging, truck transportation, production, store, you).* **Ask:** Name the kinds of things that are needed to make paper. *(trees, oil, energy, people, tools)* Remind students that papermaking also contributes to air and water pollution. **Ask:** What if they cut down a tree in your yard to make paper? How long would it take to grow another tree to make more paper? One week? Explain to students that "tree farms" are businesses that grow trees just for making paper and other products and that thousands of people are employed by this industry. **Ask:** What happens to paper when we throw it away. *(It is buried in the landfill or burned in the incinerator.)* **Ask:** What is wrong with throwing paper away? *(It takes space in the landfill, wastes trees and other resources, wastes energy and causes pollution.)*

4. Explain to students how used paper can be taken to a recycling center and later made into new paper. Discuss how recycling paper helps the environment. *(It saves trees, resources and energy, reduces pollution and waste and reuses the natural resources in the paper.)* List their answers on the board. Also write the word "recycle" and ask students to develop a definition. *(Use again, reuse, make new things from used things)*

Day 2

6. Ask students to think of ways they could reuse paper in the classroom to reduce waste. *(Use both sides, make art projects, use blank spaces to write notes, make more paper.)* Encourage students to be creative with their answers. Write their answers on the board. **Ask:** How is reusing classroom paper good for the environment? *(Reduces the quantity of paper needed to complete projects; saves trees, oil and energy; and reduces pollution.)* List their answers on the board.

7. Divide the paper from Box C among small groups of three or four students. Let each group take a few minutes to sort the paper trash from Box C into the two boxes marked: "A, Reusable Paper" *(blank spaces, art projects)* "B, Waste Paper" *(completely used).*

After the paper has been fully sorted, hand the *Paper Chase* worksheets back. Have students weigh the paper in Boxes A and B and record the value on their worksheets in the columns marked "Day 2, Box A" and "Day 2, Box B." You may want to record the weights on the *Paper Chase* overhead as well. Refer to Box B. Ask students if the paper that has been completely used must now be "thrown away." *(No, it can be recycled.)*

8. For the rest of the week, when practical, have students use paper from Box A for classroom work and assignments. When the paper has been fully used, have students discard it back into Day 3, Box C.

9. At the end of the week or when the paper from Box A has been fully used, have students weigh the fully used paper in Box C. Have them record the weight on their worksheets. **Ask:** How much paper did we reuse? Have students complete Part 2 of the *Paper Chase* worksheet.

Question for the Class

Hold up a piece of scrap classroom paper from Box A. Ask students to name three ways the paper can be reused. *(art projects, use the second side, cut into smaller pieces for memos and notes, recycle to make new paper)*

Extension Activities

1. Make recycled paper. See the instructions in the Resource section on pages 29 and 30.

2. Plant native trees on school grounds. Explain to students that trees offer so many benefits for people and animals. We should be very appreciative of the remarkable gifts they give us.

3. Plan a trip to a paper mill if there is one in your area.

4. Ask students to name: (1) all the paper products they use at home, and (2) suggestions for substitute items to use in place of paper products. Write their suggestions on the board. Have students copy the lists from the board and share with their families. For example:

Paper items	Other choices
paper napkins	cloth napkins
paper dishes	washable glasses and dishes
tissue paper	handkerchief
paper towels	dishcloths

5. Plan a field trip to a tree farm. For the location of tree farms around South Carolina, contact your County Clemson Extension office found in the phone book. Have students prepare questions to ask in advance such as the types of trees planted, number of trees planted, what they are harvested for, and how often they are replanted.

Just Do It

Start a classroom paper recycling program if your town has a Recycling Center.

Save a tree and use both sides of your paper.

Paper Chase

Part 1

Weight of the Paper

50 pounds				
45 pounds				
40 pounds				
35 pounds				
30 pounds				
25 pounds				
20 pounds				
15 pounds				
10 pounds				
5 pounds				
0 pounds				
Note: To record the weights, make a bar graph.	Day 1, Box C (All paper you would normally throw away)	Day 2, Box A (Reusable Paper)	Day 2, Box B (Waste Paper)	Day 3, Box C (Fully used paper)

Part 2

Day 1 How much does Box C weigh? _______________ pounds

Day 2 How much does Box A weigh? _______________ pounds

How much does Box B weigh? +_______________ pounds

Add Box A and Box B _______________ pounds

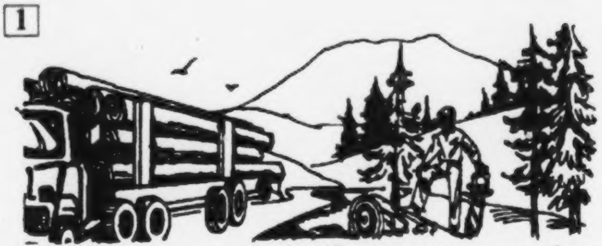
(Should weigh the same as Day 1, Box C)

Day 3 How much does Box C weigh? _______________ pounds

(This is the amount of paper that was reused before becoming waste)

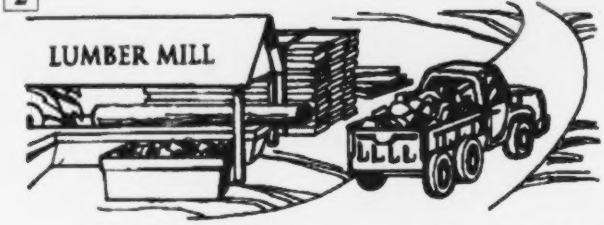
Making Paper

1



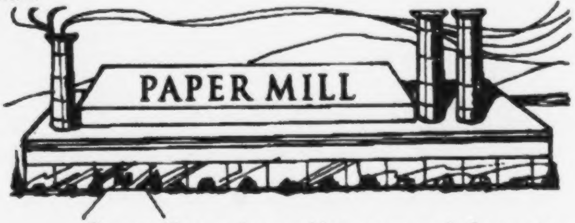
It takes 17 trees to make one ton of paper.

2



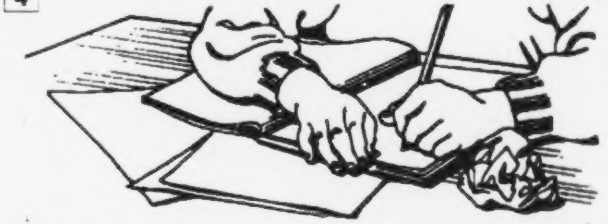
Wood wastes from lumber mills are used to make paper.

3



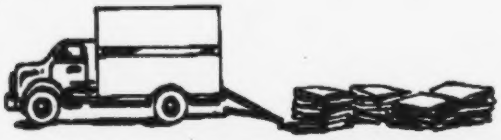
Paper mills turn the wood into paper ready for you to use.

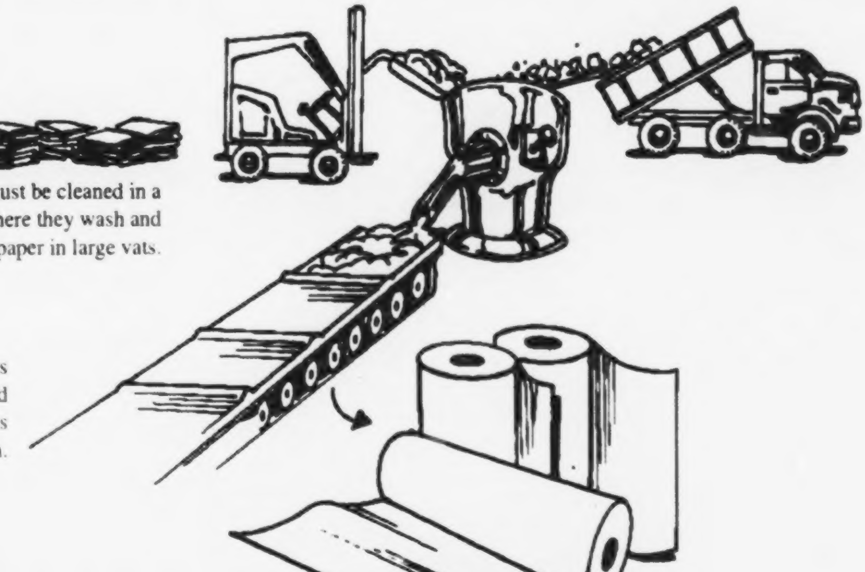
4



Once paper is used, it should be sent to be recycled, not thrown away.

5



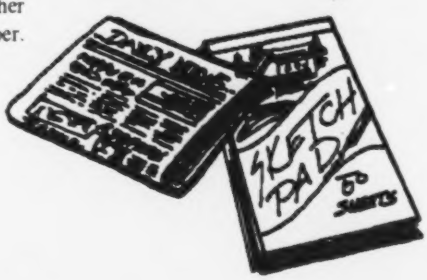


Old paper, like newsprint, must be cleaned in a processing called "de-inking" where they wash and rinse the paper in large vats.

Sometimes newsprint and wood wastes are combined, mixed into a pulp and poured onto large rollers. Other times mostly used paper is processed again.

6

The rolls of new paper are used again to make newspapers, drawing paper, computer paper, and many other kinds of paper.



Action
for a
# cleaner tomorrow.

A South Carolina Environmental Curriculum

For more information about South Carolina and the environment, call the
South Carolina Department of Health and Environmental Control at
1-800-768-7348.

The Swap & Shop & The Yard Sale Rap

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 2 – 3
Focus: Learning to reuse and repair
Subject: Social Studies, Language Arts, Music, Art
Materials: Items to trade
Teaching Time: One class period
Vocabulary: Trade, reuse, swap, repair, reduce

Learning Objective

Students will:

- discuss new uses for items they no longer want or need
- explain how reusing things reduces the amount they throw away
- see how reusing things saves resources and money.

Background

South Carolinians throw away an enormous amount of waste. Much of it is used, faded, worn or outgrown clothing, toys, furniture and housewares.

Instead of throwing these things away, try finding other uses for them. If you can't find another way to use these things, try giving or selling them to someone else who can.

Remember the old saying, "Use it up, wear it out, make it do, or do without?" Or how about, "One man's trash is another man's treasure?" These old-fashioned philosophies are back in style.

Reusing things is one of the best ways we can all **reduce** the mount of garbage we throw away. And if we don't throw things away, they can't end up in the landfill.

Think about the things you buy. Consider how long they will last before they become trash. For example, can some of the disposable items your family uses be replaced by durable items that can be reused again and again? Examples of this "new, old-fashioned thinking" is using cloth towels instead of paper towels, and avoiding things such as disposable cups and plates.

A good thing do to with durable things you don't need is to hold a yard sale or **swap** meet.

At a yard or garage sale people sell things they are finished using and don't want anymore. Instead of throwing things away, people offer them to others who will reuse them. Items at a garage sale sell for very reasonable prices because they often need fixing or **repair**.

At a swap meet people don't pay for items, they **trade** them for other things.

Learning Procedure

1. Discuss with the class the background material and what it means to reuse something.

2. **Ask:** Can you wear the same size clothes now that you did a few years ago? What happens to clothes when you outgrow them? Do you share with brothers and sisters or friends who are bigger or smaller? Is this a good idea? Why?

3. Suggest the idea of a class Swap Meet where each student brings in one item to swap for another. It is best to limit the items to a single type, such as books, to encourage fair, even trades. (With toys you may get differences in values of the items to be

In a Gallup Poll, three out of four Americans consider themselves to be environmentalists.

traded. Also with books, you may have extras on hand for students that are unable to bring something to swap from home.)

4. Explain to students that trading allows the same item to be used several times before it becomes waste. Trading is a way to make less waste.

5. Set the rules for the Swap Meet and send them home in a note to parents so everyone understands that the swapped item **will not be returned**. All items should be clean and still usable. Set aside a specific time for the Swap Meet and invite parents to attend.

6. At the Swap Meet, have students hold up their items to be traded and describe it. (With books, students may tell about their favorite part of the book, or a favorite character.) Place all items brought in for swap on a table and assign and attach a number to each one (a small masking tape tag with the number written on it works well for this.) Have a set of corresponding numbers available on small pieces of paper to place in a bag or small box. When you are ready to swap, each student draws a number from the bag and gets to take the item tagged with the corresponding number.

Teachers: this is a sample of a note you may want to send home to parents.

Dear Parents:
Our class is studying the environment. Next week we will explore how reusing things saves resources and helps keep garbage out of South Carolina's landfills.

To reinforce this, we will be holding a Swap Meet, finding new uses … or users … for items that the children no longer use. I am asking each student to bring a small, inexpensive toy or book that they no longer want or need. These will be swapped among the students and will not be returned.

The Swap Meet will be held (DATE). Thank you for your help in teaching your children this important lesson in taking care of our environment.

7. You may have several Swap Meets during the course of the year.

Extension Activities

1. Invite a guest speaker from the Salvation Army, Good Will or other local thrift store to talk to the class about how they help people by distributing items for reuse.

2. Have students draw a picture of a toy or item they used to play with or wear and show a new use for it. (This may be a younger sibling wearing a favorite dress, a toy being sold at a yard sale, or items being donated to a thrift store.

3. Read the Yard Sale Rap to the class.

The Yard Sale Rap

I already played with it.
And it was lots of fun.
But now that I am older ...
Its useful life is done.

Even though the box looks new
And I still have all the parts.
Who wants to play a baby game
That doesn't take much smarts?

Now I could toss it out.
— Just stick it in the trash —
But maybe there's a better way,
That earns a little cash.

We'll have a family yard sale
And sell old clothes that fit us funny.
I'll sell this game and more old stuff,
And I'll end up with money.

But best of all it's good to know
That I can play a part,
In seeing that my stuff gets reused
And has a brand new start!

B. Haggard

2.IV.10.F

Grandparent's Toys

Preparation Time: Easy-To-Do [✓ **Moderate**] Extensive

Grade: 2 – 3
Focus: Our solid waste contains many things we throw away because they do not last
Subject: Social Studies, Language Arts
Materials: Antique and modern toys
Teaching Time: Two class periods plus homework
Vocabulary: plastic, natural materials, whirligigs

Learning Objective

Students will:

- become familiar with the changes in what we throw away today versus the past.

Background

Toys have changed through the years. At one time, most were made of **natural materials**. Toys were made of papier-mache, or many were handmade like **whirligigs,** bean shooters, yo-yos, and tops made of wood. Over time, commercially manufactured toys became available, like wooden Lincoln Logs and Tinker Toys and metal Erector Sets. Then **plastic** toys came on the market with toy guns, Frisbees, Hula Hoops, and plastic dolls. Now battery-operated and electronic toys like video games are popular.

Learning Procedure

1. Ask students to answer to the following questions: Do you have a favorite toy at home? Have you ever had a favorite toy that didn't last very long? What happened to it? What was it made of?

2. Have students bring in toys that are broken or damaged and might be thrown out. What are they made of? How long did they last? How would the students redesign the toys to last longer? How might these broken toys be fixed or made into new toys?

3. Ask students if they've seen any of their grandparents' or others' old toys. Discuss the change in materials that toys are made from, how they are made, etc. Discuss toys made in other cultures and at other times in history. Examples of old-fashioned toys such as whirligigs or wooden blocks would be most helpful here. How are they different from modern toys? How are toys made in other cultures or at other times in history different from our toys?

4. Develop a list of questions with the students that they might ask an older person about toys. For example: What were your favorite toys when you were little? How many toys did you have? What were your toys made of? Who made them? How long did your toys last? Could the toys be fixed if they broke? Would it have been cheaper to fix the

DOWN TO EARTH

According to *50 More Things You Can Do To Save The Earth,* nearly 80 percent (4/5ths) of us have changed our buying habits because of environmental concerns.

toy or get a new one? Why? If broken toys could not be repaired, what did you do with them? How are today's toys different from those you had?

5. Have each student interview an older person about toys in the past. Students may interview an older person at home or in the neighborhood, have an older person come to the class, or take a field trip to a nursing home or senior citizen center to interview people. Taping would allow the rest of the class to learn and share. Option: In conjunction with Grandparent's Day in the fall, invite a Grandparent to class so that all students can share in the activity.

6. Discuss the differences discovered. How might these differences affect our natural resources and what we throw away? What has happened to the toys that our grandparents threw away? What will happen to our own toys when we throw them away?

Extension Activities

1. Contact a local museum, library or historical society to see if they have an exhibit on antique toys. Ask the curator if he or she will show them to your class.
2. Find out how some of the old toys were made (corn husk dolls, whirligigs, etc.) and make some in class.
3. Have each student choose and write a report about a toy that was popular in a different time and culture (Cherokee Indian toys, Egyptian toys, etc.)

Just Do It

Repair one of your toys and donate it to charity.

Purchase zinc-based batteries (zinc is relatively non-toxic).

Use the extension cord to save on batteries.

Use rechargeable batteries.

Extension Activity on Batteries

Ask the class, How many of their favorite toys run on batteries? Beside the materials used to make the toy, what happens to all the used batteries? Have you ever used rechargeable batteries? Have a class session on rechargeable batteries. Some ideas follow:

Batteries should never be thrown in the trash when they run down. They should be collected and taken for recycling. Some stores accept old batteries for recycling or they can be disposed of during household hazardous waste collection periods. Common batteries, such as the one in your toys at home, contain many different hazardous materials such as lead, mercury, silver, nickel or cadmium.

How much contamination is possible from a battery? The mercury contained in one tiny watch battery is enough to contaminate six tons of garbage. How many batteries do you use and throw away in your home? Using non-toxic, zinc-based batteries or rechargeable batteries are the best alternatives to common, "disposable" batteries.

Materials for Battery Extension

Magazines with ads for battery-operated consumer products.

Learning Procedure for Battery Extension

1. Have students clip pictures of battery-operated products from the magazines.

2. Display the pictures around the room and ask the following questions: What products shown do we need to use to help us stay alive (absolutely critical to life)? What products do we need to make our world safer or cleaner? What products do we use to make our lives easier, to save time, to provide power to to a difficult job? What products do we use for play or recreation? What products could be operated with a power source other than batteries which get thrown away when they are spent (solar-powered calculators, household electricity instead of batteries, etc.)?

2.IV.11.F

Yule Recycle

Preparation Time: Easy-To-Do Moderate **Extensive**

Grade: 2-3
Focus: Decomposition, mulch
Subject: Science
Materials: Fresh broccoli, food processor, blender or chopper, 2 potted plants, spoon
Teaching Time: Ongoing
Vocabulary: Decomposition, grinding, mulch

Learning Objective

Students will:

- discover the benefits of recycling trees
- define decomposition.

Background

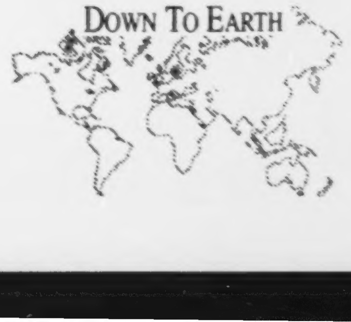
Every year Americans cut down an estimated 34 million Christmas trees. This is enough to cover Charleston County with a forest. While Christmas tree farms replant new trees each year, it is important to prevent used trees from being thrown away as garbage. (For more information on composting, see the Resource section.)

Today, hundreds of communities across the United States, and many communities in South Carolina, are recycling their Christmas trees by **grinding** them into useful garden **mulch**. In South Carolina, Christmas tree recycling programs are held statewide. Remind students that Christmas trees, like yard clippings, are banned from all landfills.

Learning Procedure

1. Cut up broccoli into spears to resemble small trees. (You may even decorate one of your broccoli Christmas trees for effect.) Explain to students:

Around the winter holidays, many families decorate trees indoors. After the holidays, instead of throwing the trees out with the trash and having them end up as garbage in the landfill, special organizations collect the trees and grind them up for mulch. Here in South Carolina this program is called the *Grinding of the Greens*. Each year in South Carolina, more than100,000 trees are taken to *Grinding of the Greens* and turned into mulch. (Mulch is used to by gardeners to protect plants and hold in moisture. Gardners who use mulch save water by not watering as often. Many gardners use pine bark or pine straw for this. Mulch should be dry before it is put on plants. This is to avoid termites.)



Building a mill designed to use waste paper instead of virgin pulp is estimated to be 50 to 80 percent cheaper.

Source: *Realizing Recycling's Potential*, Pollack-Shea

The broccoli in this lesson represents trees that – instead of being thrown away – are taken to a *Grinding of the Greens* location.

3. Using a food processor, blender, or chopper, grind one broccoli "tree" for demonstration. Point out that a large chipper is used to grind the trees. After the broccoli "tree" is thoroughly chopped, take it out and place the "mulch" around one of the potted plants. Then, put the one whole broccoli "tree" next to the other potted plant on top of the soil. **Ask:** Which tree has turned into something useful? The one that is protecting the plant, or the one that is just lying there rotting?

4. Now demonstrate to the class how grinding into mulch provides a method for reducing the volume of the used trees. Show the container of the broccoli trees that you have already prepared. Have students observe how much room these trees take up in the container. **Ask:** Which would take up more room, whole trees or chopped trees?

5. One at a time, allow several children to put a tree in the blender. Chop one or two trees at a time. After several trees have been chopped, dump the contents of the blender into the container. Continue this until you have chopped all of your trees. You may find that chopping is easier if you add a small amount of water to the blender.

Be safe! Always keep the lid tightly on the blender and remember, only turn the blender on when the teacher is holding the lid down.

After all of the trees have been chopped and dumped into the container, **ask:** How much space have we saved?

Explain to students that, because of volume reduction in mulching, an 8-foot Christmas tree yields enough mulch to fill a gallon-sized container.

6. Take both pots and place them somewhere in room where they will remain undisturbed. With students, observe what happens to the pots during the next few weeks. Explain that the mulch is good for plants and can also be put back into the soil to **decompose**.

Point out that the "tree" left to rot is unsightly and takes a long time to decompose.

Note: In some areas of South Carolina, Christmas trees are recycled whole. For instance, they are used to create beach habitats, as land retainer in building sand dunes, and in gullys to reduce erosion. In some lakes and ponds, whole Christmas trees are sunk to provide habitats for fish.

Questions for the Class

1. What is happening to the mulch?

2. Compare both pots to see what has happened. What is happening to the mulch? What happens to the whole tree? It is the same? Do you think mulching is a good idea?

Extension Activities

1. If there is not a grinding program in your area, have children write a class letter to their county council. Children may also draw pictures and attach them to their letter!

2. Read the book *The After-Christmas Tree*, by Linda Wagner Tyler, Puffin Books.

3. Have students make an ornament to hang on their Holiday Tree to remind them to recycle it. Include information about local *Grinding of the Greens* locations. Call South Carolina Clean & Beautiful at (803) 734-0141 for information.

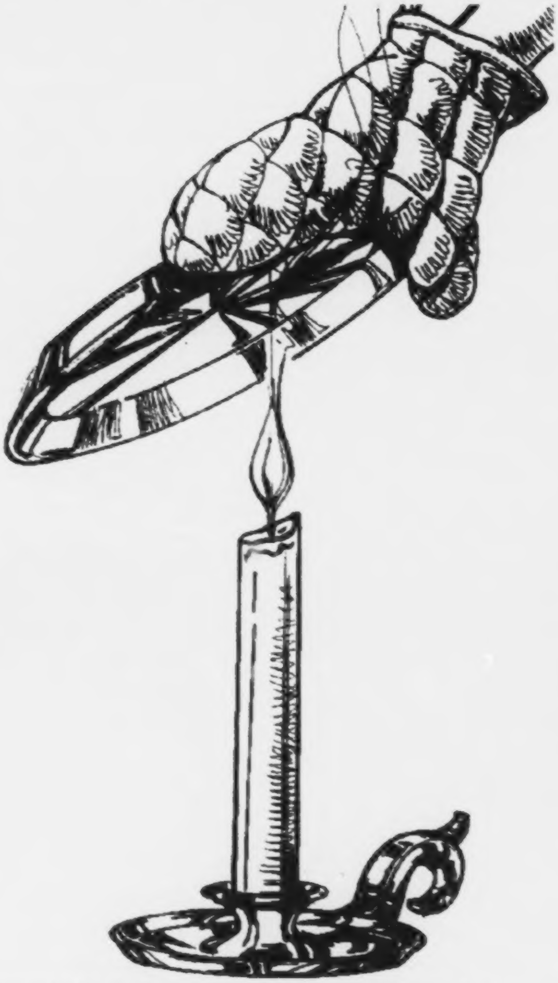
Just Do It

Take your **Christmas** tree to a *Grinding of the Greens* **program** in your **community**.

Soots Me

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 2 – 3
Focus: Open Burning
Subject: Science, Social Studies
Materials: 2 candles, holders, and aluminum pie tins for each student or each team of students, matches, kitchen hot mitt
Teaching Time: One class period
Vocabulary: soot



Learning Objective

Students will:

- observe that when something is burned, tiny particles are released into the air.

NOTE TO TEACHERS: This lesson requires your students to observe the reactions of burning candles. Should you choose to have your students perform this experiment individually or in groups, it is strongly recommended that you work outside and that you have other adults on hand to supervise the students. You can also perform this as a demonstration.

Background

Open burning, that is burning of trash, leaves, limbs, etc. outdoors, is discouraged in all South Carolina communities. And in many cases it cannot be done without permission from local authorities. To obtain permission or to check local regulations, you may contact your local DHEC office or the S.C. Forestry Commission.

One reason for controlling open fires is to help reduce potentially harmful particles from being released into the air. These airborne particles can cause eye irritation and respiratory problems, especially in the young, elderly and those who already suffer from breathing problems.

Learning Procedure

1. Place the two candles in their holders. Light only one of them. Set the other one aside.

2. Observe the two candles. **Ask:** is there anything different about these two candles? Can you see anything above the flame of the burning candle? Have the students record their observations.

DOWN TO EARTH

The use of wood-burning stoves in the mostly rural state of Vermont increased greatly during the 80s. This created levels of airborne particulates usually found in large urban areas.

The Information Please Environmental Almanac, 1993

3. Using a kitchen hot mitt, hold one of the aluminum pie pans a couple of inches over the flame. Be careful not to touch the flame.

4. After about 15 or 20 seconds, remove the pan and set it aside. Blow out the candle.

5. Hold the other pie pan over the candle that is not lit for the same amount of time. Look at each pie pan and record what you see.

Questions for the Class

1. What produces soot?

2. Where would the soot have gone if you had not collected it with the pie pan?

3. Name three other sources of soot.

Extension Activities

1. Interview parents and grandparents about burning leaves in the fall. Was this a common practice? Do they still do this?

2. Research fireplaces and wood-burning stoves. Do people still use these and do they contribute to air pollution?

Just Do It

Limit the use of fireplaces and wood-burning stoves at home if possible.

Student Worksheet

Name: ______________________________

Above the flame of the lighted candle, I observed: ______________________________

____

____

Above the un-lit candle, I observed: ______________________________

____

____

On the pie tin above the lighted candle, I observed: ______________________________

____

____

On the pie tin above the un-lit candle, I observed: ______________________________

____

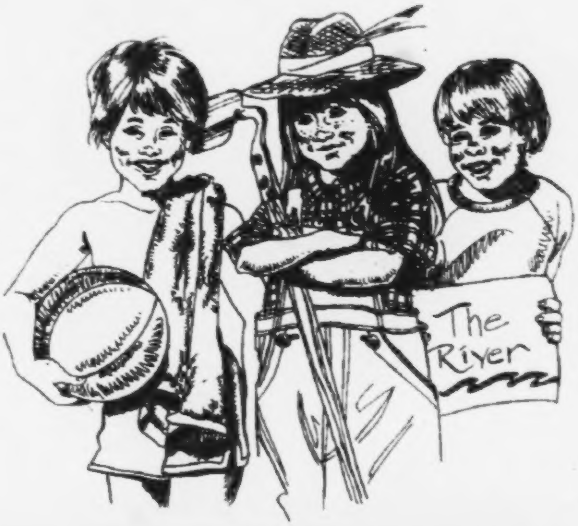
____

The River Flows Along

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 2 - 3
Focus: How activities on land contribute to pollution of our water.
Subject: Science, Social Studies, Health, Art
Materials: Various costumes and props, see list itemized
Teaching Time: Several class periods
Vocabulary: Pollution, litter, soil, erosion, fertilizer, chemicals

Note: This is a role playing and story telling activity in which students act out the various activities that take place along a river. It works well for students to add costumes and props to enhance their roles. You may adapt the story and roles to waterways in your area.



"The River Flows Along" is a role play activity that lets students play the parts of people along a river. "Please be careful," cries the River to the people. "What goes on the ground can flow into my water when it rains."

Learning Objectives

Students will:

- see how wastes from activities on land can pollute our water
- see how each person can help keep our water clean.

Background

When it rains, water washes across our land taking with it many different things that can **pollute** our water or make it dirty. Much of this pollution can be prevented by people. In this simple story-play activity, students act out life along a river and see how a few simple actions can help keep the river clean for every one to enjoy.

Learning Procedure

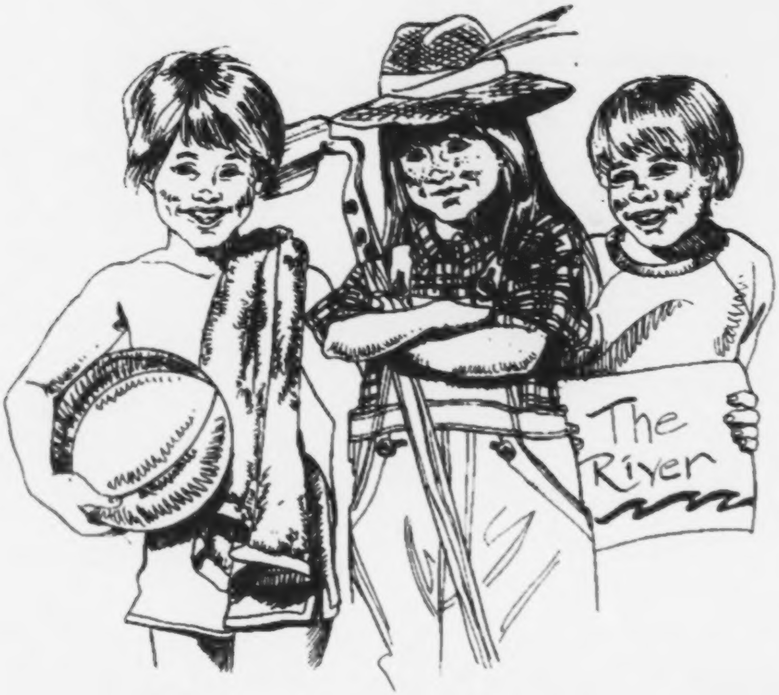
1. Have students select parts from the role play and bring in costumes and props to support their parts.

2. Read the story as students step forward to act out their parts. After the story, have students discuss how to help keep our waters clean.

DOWN TO EARTH

In Italy, most lakes and rivers are too polluted for swimming.

source: *1994 Environmental Almanac*



Materials

The story "The River Flows Along," included with this lesson, is the basis for the role play. Use costumes and props to simulate life along the river.

- **The River** - (Several students for this part, form a chain that flows along.) Costume ideas include dressing students in blue, creating a large cardboard wave for students to carry, creating a sign that names the river, etc.)
- **The Farmer** - Props may include a straw hat, overalls, hoe, fertilizer sack.
- **The Animals** - (Several students can take this part.) Props may include costumes or masks for cows, horses, pigs, straw, a sign that says, "Barnyard" or stuffed animals that the children hold.
- **The Construction Engineer** - Props may include a hard hat, rolled paper to look like blueprints, a toy dump truck, etc.
- **The Gardener** - Props may include a hat, flowers or basket of vegetables, gardening gloves, a spray bottle or watering can, etc.
- **The City** - Props may include a toy building, a toy bus or signs or cardboard cut out of buildings.
- **The Picnicking Children** - (Again, several students can take this part.) Props include a picnic basket with throwaway items such as paper plates and napkins that will serve as examples of litter.
- **The Homeowner** - Props may include a toy lawn mower, an apron, a cleaning brush and bucket, toy cars to wash, a bucket and sponge, a garden hose, etc.
- **The Swimmers** - (Several students may take this part.) Props may include bathing suits, floats, beach towels, etc.

The River Flows Along

Once upon a time, there was a gently flowing river, the ______________________ (Name your river) And like all rivers, the ______________________ (Your river) rippled with cool, clean, fresh water as it flowed down from the South Carolina mountains.

Many kinds of fish (Name local fish found in your area) called the river home and many small animals drank from the water as it passed by on its way downstream.

At a bend in the river, it passed a farmer's green fields. The farmer **fertilized** the fields to help the crops grow tall, but when it rained some of this fertilizer ran off the fields and down into the river. And while this fertilizer helps plants grow on land, it can be harmful if too much runs off. "Please be careful," cried the river to the farmer. "What goes on the ground can flow into my water when it rains."

Just beyond the fields, the river passed the farmer's barnyard. The animals all love to drink at the water's edge and to rest by the gently flowing water. But when too many animals gather at the water's edge, the water can get dirty. "Please be careful," cried the river to the animals. "What goes on the ground can flow into my water when it rains."

The river flowed on from the countryside to a place where office buildings were being built right along the river. While the river welcomed people to enjoy the water, it worried as the construction engineers cut trees and scraped away the green grass from its banks and built buildings and parking lots. When it rained, dirt and **soil** from the bare land ran into the river and turned the blue waters muddy. "Please be careful," cried the river to the engineers. "What goes on the ground can flow into my water when it rains."

As the river widened it passed more and more buildings until an entire city lay on its banks. The city was exciting, with many cars and people rushing here and there. There was so much for the river to see, but there was also so much from the city that ran into the river. Each time it rained, the water washed over the city buildings and streets and carried dirt into the river. "Please be careful," cried the river to the people. "What goes on the ground can flow into my water when it rains."

At a city park, many children came to picnic. And while the river loved seeing them play and hearing their laughter, it was sad when the children left **litter** behind that would blow into its water. "Please be careful," cried the river to the children. "What goes on the ground can flow into my water when it rains."

Past the city, the river narrowed again as it flowed on past several housing developments where many families lived. The river was a fun gathering place for everyone. But the river didn't enjoy it when the homeowners would let car washing **chemicals** and bug sprays wash off and run down to the river. "Please be careful," cried the river to the homeowners. "What goes on the ground can flow into my water when it rains."

And the river just couldn't understand why all the people along its banks weren't more careful. After all, they all wanted to fish from the river, and drink from the river, and swim in the river. The river wished that everyone would remember... "Please be careful, what goes on the ground can flow into my water when it rains."

Extension Activities

1. Have students create a classroom mural of their river from the story, "The River Flows Along." Each student can create a panel that shows one type of activity (from the story or their own idea) along the river. Have each student color the bottom or top third of the paper blue to represent the river, this way the river can flow from panel to panel when you connect all the panels to make your mural. As you assemble the mural, let each student describe the activity drawn and ideas about how to safeguard the river from pollution.

2. **Can we see what's really in our river?** Students may say that even though they know that there is activity along a river, they have never seen the pollution in a river. In this activity, students discover that just because we can't see things in our water doesn't mean that they aren't there.

Materials for this extension activity:

- sugar (1 cup)
- water
- a clear container such as a clear two liter soda bottle
- measuring cup
- small, clear drinking cups
- spoon for stirring.

Ask: Can we see pollution in our waterways? Discuss with students that some things such as litter and oil can be seen but that many other things such as chemicals can't be seen in our water.

- Mix 1/4 cup sugar (representing a chemical that has run off land) with 1 cup water. Ask students what they see. (Students may see some of the sugar granules in the water. Keep stirring until dissolved completely.)
- Pour a small amount of the sugar water mixture into small cups for each student to taste. Ask them if they can taste the sugar that they saw.
- Repeat the test with 1/4 cup sugar in 2 cups of water. Again have students observe if they can see the sugar in the water and if they can taste it.
- Repeat the test with 1/4 cup sugar in 3 cups water, and with 1/4 cup sugar in 4 cups of water. Each time ask students if they can see what you added to the water and then have them taste the water and say if they can taste the sugar.

Students should conclude that they can't see the sugar in the 4 cups of water but that they can taste it. Explain to students that this is how it is with many forms of water pollution, we can't always see it. Ask students to name some chemicals that could end up in water that they couldn't see but that could cause harm. (Bleach, some pesticides, ammonia, etc.)

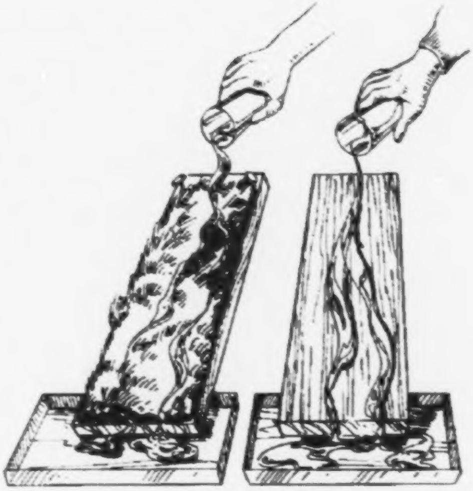
Can You See What's In The Water?

Sugar	Water	What I See	What I Taste
1/4 cup	1 cup		
1/4 cup	2 cups		
1/4 cup	3 cups		
1/4 cup	4 cups		

Runoff Race

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 2 - 3
Focus: How water gets polluted.
Subject: Science
Materials: See list of materials itemized below
Teaching Time: 45 minutes
Vocabulary: Runoff, waterways, pollution, fertilizers, pesticides, groundwater, wastes, wetlands, litter



Learning Objective

Students will:

- see how rain water moves across our land
- see how plants help keep this runoff from entering our waters
- understand the role wetlands play as a buffer between dry land and waterways.

Students will see how plants help slow the flow of **runoff** water, rainwater that moves across land, and how this helps keep our **waterways** clean.

Materials

For sediment demonstration:

- clear quart container with lid
- small pebbles, sand, dirt, crushed leaves
- water

For the runoff race, also see illustration:

- two flat pans or boards (no lip)
- two shallow pans with low sides
- piece of grass, artificial turf mat or other very textured material
- way to adhere grassy material to pan
- two equal containers of water
- something to prop up pans (books)

Background

When it rains, water flows across the land carrying with it wastes that can pollute our water and threaten the many living resources that depend upon clean water. Some of these pollutants come from our farms and fields (animal waste, **fertilizers, pesticides**), our city streets (oil, soot, **litter**), and our own backyards (household chemicals, fertilizers, pesticides). Other **wastes** come from natural sources. Pollutants enter waterways with rain, runoff, and **groundwater**, or are dumped directly into the water. Once in our water, they are carried along with the flow of water and are difficult to remove.

One way to stop this waste from polluting our water is to be very careful about what we discard and very careful about how we use our land and alter our landscape.

DOWN TO EARTH

In the United States, between 50 to 70 percent of threatened surface waters are affected by nonpoint source pollution from agricultural activities.

source: U.S. EPA

Wetlands, plant areas that are the land-water border, are helpful in keeping soil in place and slowing runoff that may contain waste that can contaminate our water. Wetlands are often the last stopping place for runoff before it enters water. Wetland plants slow the flow of water enough to allow time for the heavier particles to settle out. Smaller particles will be trapped in the mesh of leaves, stems, and roots created by densely vegetated wetland. Fine silt particles are often found on wetland plants meaning that the water flowed on without them.

Learning Procedure

Note: This may be done in groups or as a demonstration. For best results, practice with your materials ahead of time. There are two demonstrations in this activity.

1. **Ask:** "What happens to the rain when it falls? Where does it go?" Explain how the rain flows across everything – our houses and yards, buildings and streets, farms and fields, etc. Discuss how the rain picks up dirt and other things and carries them along. Ask students what types of things the rain can carry. (Dust and dirt, oil from the road, leaves and twigs, litter, fertilizer and chemicals from fields, etc.)

Ask students if they have ever seen a stream or river flowing along. Explain that the faster the flow of water, the more dirt and other things it can carry with it and that too much of this can pollute our water and damage the environment.

2. Demonstration One: mix different sediments – sand, dirt, etc. – together in the clear container, filling half the container. Top off the container with water and put on the lid. Have a student shake the container until thoroughly mixed and set the container where all students can see it.

As the class watches the sediments settle, explain that muddy water can be harmful to wildlife. Ask students if they can think of reasons why. *(Muddy water clogs fish gills, smothers fish eggs, blocks sunlight and effects plants growth, etc.)*

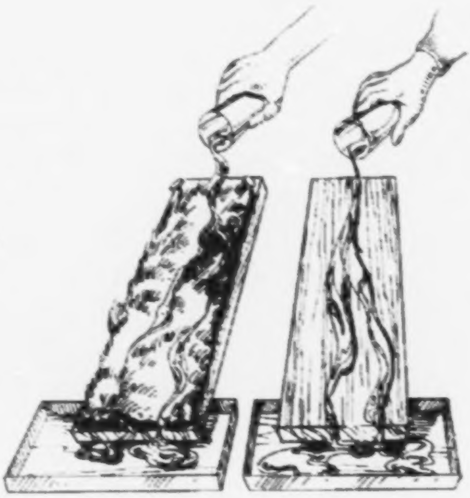
Ask: "Would more sediments settle to the bottom if the water was flowing quickly or slowly?" *(Slowly. Slower flow means smaller particles settle out and do not flow on with the water.)*

Describe how the particles are settling in the jar in layers, the largest or heaviest first. Fine or light particles may not settle at all. Small pieces of leaves, twigs, and bark may float on the surface.

Describe how wetlands and plants can slow the flow of water by simply being in the way.

3. Demonstration Two: Show students the model and explain how the slick model represents bare ground and that the green side (with a door mat or grass covering) represents a healthy wetland with plants. In both, rain falls and streams downward, flowing toward a lake (the pans at the end).

Have students participate by pouring "rain" from a container or watering can onto the top end of both models at the same time. See the illustration.



Ask: "In which model does the water flow fastest?" *(The bare one without the healthy plants.)*

In which area – wetland or bare ground – would more particles or sediments settle out? *(The* *healthy wetland will cause more dirt to settle out and will keep more particles or pollution out of our water.)* Which one would have cleaner water flowing from it? *(The healthy wetland.)*

How would digging a ditch through a wetland affect water quality downstream? *(Digging a ditch through a wetland would create a path for water to flow through quickly, without passing through the wetland plants. This would mean that the filtering action of the wetland would be diminished, and the water quality downstream would be lessened.)*

4. Discuss why someone might dig a path through a wetland area. *(Usually digging is done to drain a wetland to make the land more useful for farming or building.)*

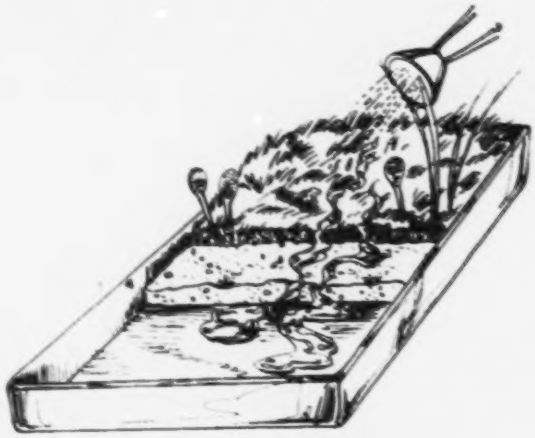
Why is it important to preserve wetland areas? *(Wetlands help keep our water supply clean.)*

Extension Activity
Wetland in a Pan

1. Have students make their own wetland models individually or in small groups. These instructions may be modified for materials available. (See illustration.)
   - Use any pans that will hold water such as baking pans or plastic containers. (A long pan works best.)
   - To build the slope, have students use clay. Leave half of the pan empty to represent the lake, river or ocean at the end of the wetland area. Have students shape the clay so that it gradually slopes down to where the water will begin. Smooth the clay along the sides of the pan to seal the edges.
   - Use a covering for the slope to represent the wetland plants or buffer between the dry land and water. This covering may be a piece of old carpeting, felt, toweling, real turf, or any type of textured matting. Be sure that the covering fits well. The model won't work if there are spaces under the wetland surface or down the sides of the pan.

2. Have students review the features of their wetlands. Explain that wetlands, like all habitats, are complicated natural systems. Wetlands perform some very important functions such as filtering pollutants, reducing flood damage, and preventing soil erosion. Have students rain on their wetlands and observe how the "plant" area (the carpet or matting) slows the flow of water.

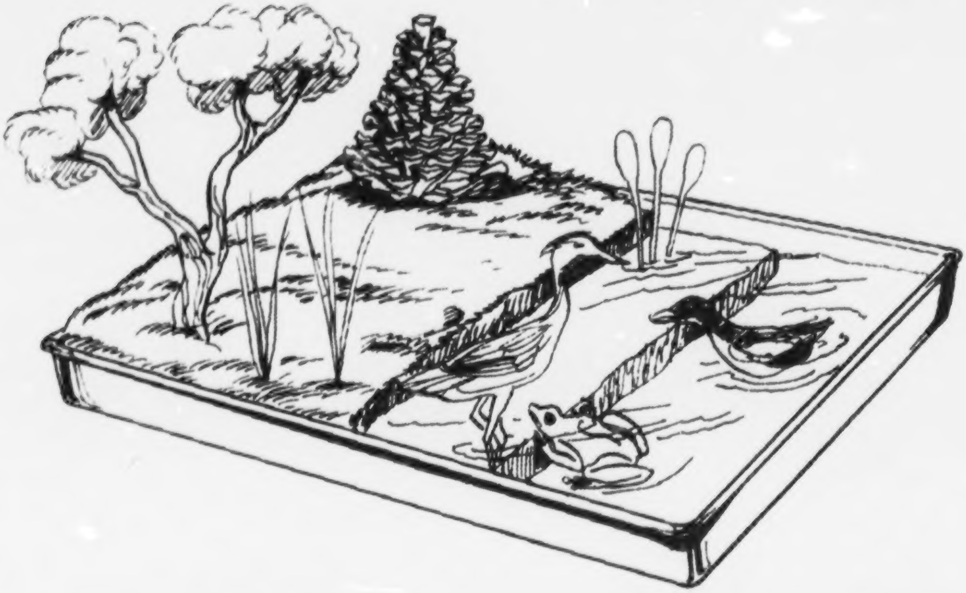
3. Have students add wetland features to their models. See the illustration for ideas. Students can make fresh water or salt marsh models. Here are some ideas:
   - Use cotton swabs for cattails. Students can paint the stems green and tops brown.
   - Use pine needles for reeds.
   - Make wetland creatures. Students can use the patterns included with this lesson or can make their own. Tape them to toothpicks.
   - Small pine cones make nice trees or use small twigs with leaves.

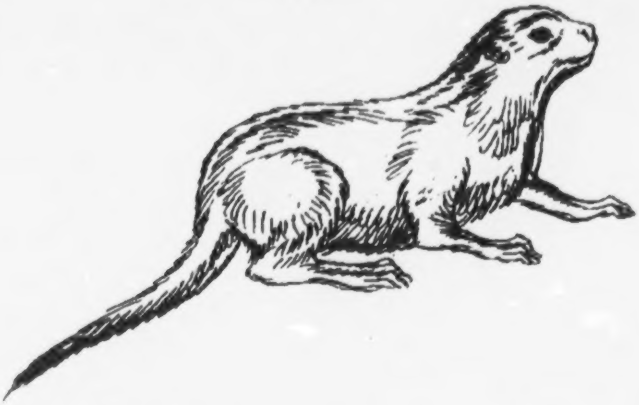


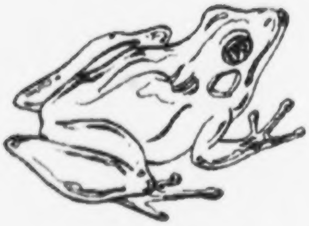
Just Do It

Find a wetland in your area.
Is it protected? Find out
what you can do
to help protect it.

Wetland In A Pan







How Conservative Are You?

Preparation Time: **Easy-To-Do** Moderate Extensive

Grade: 2 - 3
Focus: Water conservation
Subjects: Science, Math, Art
Materials: Plastic milk container, measuring cup, measuring spoons, wall clock or watch
Teaching Time: One class period and a few days for monitoring
Vocabulary: Conservation

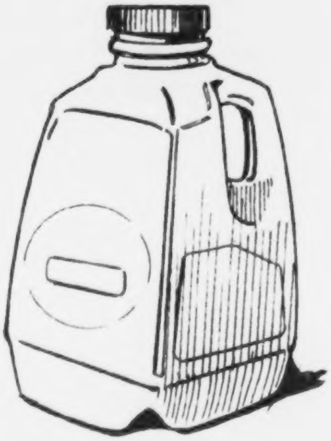
Learning Objective

Students will:

- measure the amount of water lost from a leaking faucet in one school day
- make a picture to represent this amount
- measure the amount of water lost while waiting for hot water at the tap
- design a way to represent this amount
- list ways to conserve water at the home.

Background

From out in space, our blue planet Earth looks like it is made up of nothing but water. It would seem that there is enough water to last forever. Here on the surface of Earth, we know that is not true. The oceans are full of water too salty for most animals and plants to use. Only a small portion of Earth's water is fresh water. Much of that is found deep in the ground or frozen on the surface as snow and ice. We must be very careful with the fresh water sources that we have to make sure we don't pollute them or waste them and use up all of our clean water.



One way to take care of our precious fresh water is to practice water conservation in our homes and schools. **Conservation** means to save and protect. Everyone knows not to pour oil onto the ground so that it ruins our water deep in the ground. Everyone knows not to dump wastes into streams or rivers. We are doing a pretty good job with protecting our fresh water sources. But are we doing as good a job to save Earth's fresh water? Do you let the water run when you shower or brush your teeth? Do you let the water run until it gets cold for a glass of water or until it gets hot to wash your face? All of these are wasteful activities.

Learning Procedure

1. Most people think that only a little water is wasted each day. When your class first starts in the morning, go to a water faucet that your class can monitor all day. Turn on the faucet so that it barely drips. Place a clean plastic milk jug under the faucet. From time to time during the day, check to see how full the jug is getting. (If you need to, remove the first jug and start on another.)

DOWN TO EARTH

If your water has high concentrations of lead, flush the cold water line each morning by letting the water run until the water is as cold as it gets. DHEC can provide the names of reputable water-testing laboratories. Call 1-800-SO-USE-IT.

2. At the end of the day, turn the faucet off tightly and bring the jug or jugs of water to the class. Cap tightly.

3. The next day, pour the water from the jugs into the measuring devices and carefully measure the water that came from the "dripping" faucet. Then discuss how many faucets are in your hallway? How many faucets are in all the bathrooms at your school? If all of these faucets dripped the same amount of water as your "test" faucet, how much good, clean water would be wasted by your whole school in one day? What if the faucet leaked for a whole year? Calculate the estimated amounts.

4. Most people prefer warm water when they wash their face before bed and in the morning. When you turn on the tap, the first water out is usually cool. It takes a few minutes for the water to be warm enough to wash your face. The water that pours out of the faucet while you are waiting for warm water is all wasted.

Again, take the class to a nearby faucet. Have a milk jug ready to measure the wasted water and have a timer ready to see how long the water takes to get warm. Turn on the hot water faucet. Start timing. Place the milk jug under the faucet and collect all the water until you reach the point where the water is hot enough to wash your face. How long did it take for the water to get warm? How much water went down the drain in this time? If you did this twice a day, how much water would be wasted? If everyone in your family waited for warm water to wash their face twice a day, how much water would your family waste in a day?

5. Graph to show how much water a family of four would waste in one day if they let the water warm up to wash their faces two times a day.

Extension Activity

Divide the class into small groups. Have each group come up with two ways to save water both inside and outside their homes. Start the groups by having them think of everything their family does that uses water. What are some uses for water that pours down the drain while you are waiting for the temperature to warm up?

Just Do It

Don't reach for warm water when cool water will do. You'll be saving water and energy.

The Water Cycle

Preparation Time: **Easy-To-Do** Moderate Extensive

Grade: 2 – 3

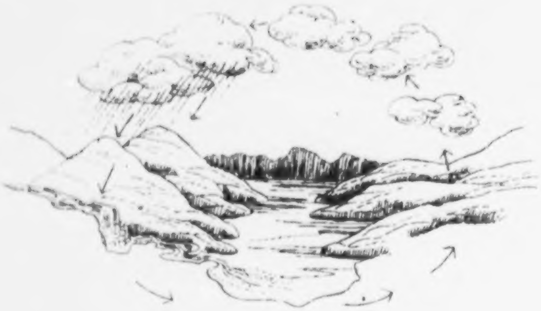
Focus: The hydrologic cycle

Subjects: Science, Drama, Physical Education

Materials: role playing tags, crayons, scissors, hole punch, string, bucket, 13- 3 oz. paper cups, 10- 8 oz. paper cups, 5- 16 oz. paper cups, water, chalk and chalkboard, umbrella (optional).

Teaching Time: One class period

Vocabulary: Cycle, water cycle, water vapor, cloud, rain, temperature



Learning Objective

Students will:

- discuss the water cycle
- role play the water cycle by physically moving water from place to place.

Background

Many things in our natural world go through a **cycle**. If you think of the words "bicycle" and "tricycle," you will hear that part of their name ends in "cycle." Think of a bicycle wheel. It is a round circle. Water goes through a circular path or "cycle" out in the natural world. It goes from a body of water, like a lake, into the air as **water vapor**. As the droplets of water in the air come together and get bigger, they become a **cloud**. As more and more clouds fill the sky, and more and more water vapor goes into the air, we get large water drops of **rain**. This rain eventually returns to the lake to start the cycle over again. Think of a warm summer day. The whole circle for water usually happens in one summer day.

Learning Procedure

1. Cut out and hole punch the role playing tags and have each student draw one tag out of a hat to determine the role they will play. Let the students color their tag. Tie a string through each tag so that it can be worn around the neck (or you could pin them on). You should have the following actors: the sun (1), the lake (1), water vapor (13), clouds (10), rain (5). This set is for 30 children. Adjust roles as necessary for your class size. Have everyone put on their tags.

2. Line up the students so that the lake child is on one side of the room and the cloud students are standing on the other side of the room. Have the sun, the water vapor, and the rain stand in the front of the room to wait their turns. Place the bucket of water on the classroom floor next to the lake child. Give each of the "water vapors" a 3 oz. paper cup. Give each of the "clouds" an 8 oz. paper cup. Give each of the "raindrops" a 16 oz. paper cup. The sun does not get any container.

Down To Earth

The Three Gorges project in China is the world's largest hydroelectric power dam. When it is complete, it will be 600 feet high and create a 370-mile-long lake on the Yangtze River.

Source: The Information Please Environmental Almanac, 1994

3. Begin with the "lake." Have the "sun" go to the lake. Have the sun hold up his/her arms and shine (wiggle fingers) down on the lake. What happens to the lake temperature? Now have the "water vapors" come and fill their cups at the lake and carefully carry the water "up" to the clouds. When the water vapors get to the clouds, they should each pour their water into a cloud cup (no more than two water vapors per cloud cup). The sun can sit down and the water vapors can sit down.

4. Now have the clouds move close together. Have the "rain" students come over to the clouds. Have the clouds empty their cups into the rain cups (again, no more than two clouds per rain cup). Have the rain students carry their water back to the lake and empty it into the lake bucket. Make a lot of noise with your feet as if rain were falling. You can open an umbrella for added effect. The clouds, rain, and lake all sit down.

5. Discuss what has happened to the water. Draw a big circle on the chalkboard and label (use the symbols on the role tags) as the water goes from lake to water vapor to clouds to raindrops to lake. Who started the process and got this circle going? Who had the most water? Who had the smallest amount of water? Can you really see water vapor? Can you see clouds? What are clouds made of? Can you see water in raindrops? Did any water get wasted? Was any water left anywhere?

Just Do It

Stop and watch the clouds. You'll see changing shapes and designs as the clouds go by.

Sun

Lake

Water Vapor

Water Vapor

Water Vapor

Water Vapor

Water Vapor

Water Vapor

Water Vapor

Water Vapor

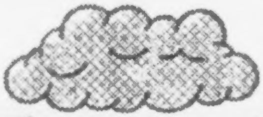
Water Vapor

Water Vapor

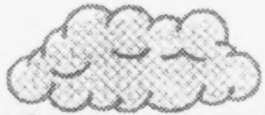
Water Vapor

Water Vapor

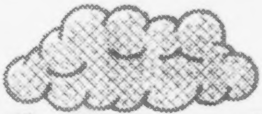
Water Vapor



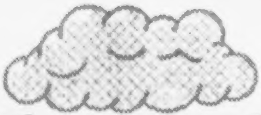
Clouds



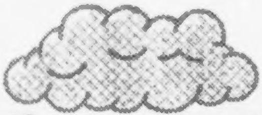
Clouds



Clouds



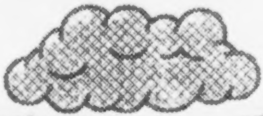
Clouds



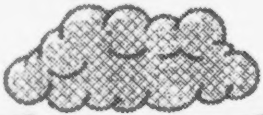
Clouds

Clouds

Clouds



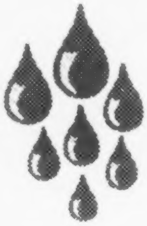
Clouds



Clouds

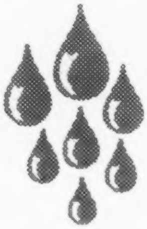
Clouds

Rain

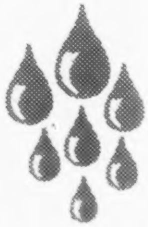


Rain

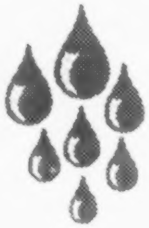
Rain



Rain



Rain



Action for a cleaner tomorrow.

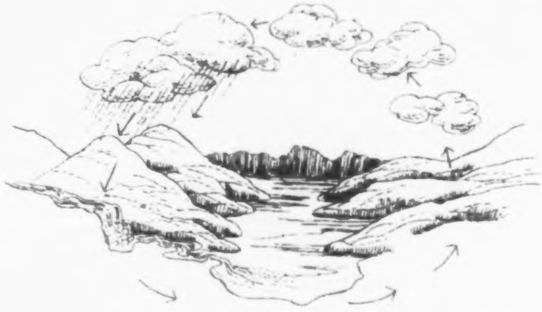
A South Carolina Environmental Curriculum

For more information about South Carolina and the environment, call the South Carolina Department of Health and Environmental Control at 1-800-768-7348.

The Mini Water Cycle

Preparation Time: Easy-To-Do Moderate **Extensive**

Grade: 2 - 3
Focus: The hydrologic cycle
Subjects: Science, Meteorology
Materials: Approximately two quarts of hot water and, for each student, have a set of the following: one 3 oz. paper cup, two paper towels, one 4" square of clear plastic wrap, one rubber band, and one ice cube.
Teaching Time: One class period
Vocabulary: Water cycle, water vapor, rain



Learning Objective

Students will:

- discuss the water cycle as it occurs in nature
- create a water cycle at their desk
- match the parts of the natural water cycle to the parts of "the mini water cycle."

Learning Procedure

1. Draw the **water cycle**, as seen in the lesson entitled *The Water Cycle* on page 69, on the chalkboard. Review all of the parts.

2. Tell students that we can create a "mini" water cycle at our desks by using water that has already been heated. How would the water get hot in nature? *(The sun.)* To make it cold like it would be high up in the clouds, use an ice cube. (Remind everyone that there is snow on top of high mountains and astronauts have to bundle up out in space because it is so cold high above the earth.)

3. Pass students a 3 oz. paper cup, a piece of plastic wrap, and a rubber band. Place paper towels under the cup to absorb any spills.

4. Heat some water on a hot plate or in a microwave. The water should be hot but not boiling in the event a child spills it. Fill each child's cup about 1/3 full of the hot water.

5. **Ask:** Is there **water vapor** moving up from the hot water into the air in the cup? Can you see the water vapor?

6. Stretch the square of plastic wrap over the mouth of the cup and secure it in place with a rubber band. (You may need to help younger students.)

7. Explain that we have trapped the water vapor in the cup.

8. Cool the vapor to create some **rain** (and see the water that was vapor). Give each student an ice cube. Put the ice cube on top of the plastic wrap. Wait for a minute or two. (You might have a cup with the plastic wrap and rubber band set up on your desk as a model.)

DOWN TO EARTH

Nearly one-half of Japan's lakes and water bodies have experienced some degree of acidification from acid rain.

Source: The Information Please Environmental Almanac, 1994

8. After the minute is up, take whatever remains of the ice cube off of the plastic wrap. With the paper towel, carefully wipe any melted water off of the plastic wrap. What do you see on the underside of the plastic wrap? Gently tap the plastic wrap and watch the droplets fall back into the cup. Remove the rubber band and carefully take the plastic wrap off of the cup. How did the water droplets get on the underside of the plastic wrap? How did the water get from the bottom of the cup up onto the plastic wrap? Why couldn't we see the water vapor rising?

9. Go through the natural water cycle again, this time pointing out each part in relation to the parts of the mini water cycle in the cup. Hot water equals the sun warming the lake. We can't see the water vapor rising up. The cold ice is like the cold air up high in the sky. The water vapor comes together into big drops when it gets cold. We can't see any clouds in our little cup, but if the water droplets get big enough, they will fall like rain back down into the hot water. We made some "rain drops" fall from the condensed water vapor on the bottom of the plastic wrap.

Extension Activities

1. The air around us has water vapor in it. Can we make some water vapor "appear" out of the air around us right now? Fill a tin can with tap water. Feel the outside of the can. It should be dry. We need to cool the water in the tin can. How can we do that? Put some ice cubes into the water. Wait one minute. Feel the outside of the tin can. Is it dry? Where did the water droplets on the outside of the can come from?

2. The mini water cycle set up can be used to show that when water evaporates it leaves behind most pollution to concentrate in the lake. Repeat the mini water cycle, but put a drop of red food coloring (pollution) into the hot water. When the droplets of water vapor condense on the underside of the plastic wrap, look to see if there is any red coloring? What happened?

Action for a cleaner tomorrow.

TABLE OF CONTENTS
GRADES 4 – 5

Title	Discipline	Focus	Page
Litter Scavenger Hunt	Science, Language Arts, Social Studies	Source of Litter	1
Litter in the Wild	Math, Science, Social Studies, Language Arts	Litter Affects Wildlife	5
Litter Charades	Social Studies, Science, Language Arts, Art	Litter Endangers Wildlife	11
Look in Your Garbage Can	Math, Social Studies, Science	Garbage Awareness	15
If It's All the Same to You	Social Studies,Science, Language Arts, Health	Household Hazardous Waste	19
Batteries	Science, Art, Physical Education, Economics	Batteries	27
Hauling It Away	Science, Social Studies, Math	Cost of Hauling Trash	31
Making a Simulated Landfill	Science, Language Arts	Landfills	33
Counting Our Resources	Science, Language Arts, Social Studies	Resources/Recycling	37
Trash Flash Through Time	Social Studies, Language Arts	Reducing Trash	41
Trash or Treasure	Social Studies, Language Arts	Reuse	47
Story of Packaging	Social Studies, Language Arts	Reduce Packaging	49
Solving the Can-Can Mystery	Social Studies, Science, Language Arts	Recycling Cans	53
Plastics by the Numbers	Social Studies, Science	Plastics Recycling	57
Waste Management & The Law	Social Studies, Language Arts	Waste Management & the Law	63
Stick 'em Up	Social Studies, Science	Airborne Pollutants	67
Today's Forecast	Social Studies, Science, Geography	SC Weather Patterns	69
The Air In Here	Social Studies, Science	Indoor Air Quality	75
Nature's Water Wheel	Social Studies, Science	The Water Cycle	77
Runoff: It's a City & Rural Concern	Social Studies, Science	Runoff Pollution	85
We All Live Down Stream	Social Studies, Science, Art	Watersheds	89
Clouds and Water Vapor	Meteorology, Science	Clouds	91
Evaporation	Meteorology, Science	Evaporation	93

Water and States of Matter	Meteorology, Science	Water	97
Wells	Geology, Science	Wells	101
Energy to Produce Food	Social Studies, Science	Energy	105
Conserving Energy	Math, Science	Insulation	107
Living Without Power	Language Arts, Social Studies	Energy	115
Power in South Carolina	Social Studies, Science	Electricity in SC	123

Litter Scavenger Hunt

Preparation Time: **Easy-To-Do** Moderate Extensive

Grade: 4 - 5
Focus: Sources of litter
Subject: Science, Language Arts, Social Studies
Materials: Scavenger hunt list, recyclable grocery bags for use as litter bags, gloves
Teaching Time: 45 minutes
Vocabulary: Litter, pollution, man-made, natural, degradable, recyclable

Learning Objectives

Students will:

- observe, gather and discuss litter in the schoolyard
- recognize the variety and sources of litter
- discuss the negative impact of litter on the environment in terms of pollution and loss of resources
- apply definitions to terms used to classify materials
- write a paragraph that describes the who, what, where and why about one object that became litter.

Background

Many of the items people **litter** contain resources that can be recycled. The difference between throwing an apple core on the ground and throwing an aluminum can on the ground is that the apple core will **decompose**, returning nutrients to the soil while the can remains as litter. Littering of **recyclable** objects, such as paper, glass, plastic bottles and metal cans robs the environment of the resources and energy components locked within them.

Along with making an area look trashy, littering can injure animals that step on broken glass or drink contaminated water from containers. Small animals can become trapped inside bottles. People can be injured by stepping on broken glass or rusty metals.

Most people are unaware of the damage they do when they litter. To some people, it seems easier to drop fast-food wrappers on the ground than to carry them to a waste can ... or to think of the consequences of littering.

In South Carolina, littering carries a maximum fine of $1,000, and repeat offenders can be jailed.

Learning Procedure

1. Write the words **litter**, **pollution**, **natural**, **man-made**, **degradable**, and **recyclable** on the board. Help students develop definitions for each word. Encourage students to define the terms in

Residents of Seattle, Washington, recycle 45 percent of their household waste.

relation to the environment. *(**Litter** is man-made or man-used waste that can pollute the water, spoil the beauty of nature or injure people or animals, items such as broken glass, paper or plastic trash and rusty metals. **Pollution** means to make dirty, unhealthy or unsafe. **Natural** means grows or is made by nature. **Man-made** means that people use natural materials to make things they can use. **Degradable** describes a natural object that can decay, rot or decompose like leaves, apple cores and pine cones. **Recyclable** describes an item that is made from resources that can be used again to make something new.)* Have the students use these words in writing sentences.

2. Explain to students that they are going on a scavenger hunt to explore and document the litter problem in their schoolyard or neighboring community. If using the school yard, you may ask the maintenance staff to let litter collect for a day or so. Students may work alone or in groups of four or five. Invite parents to join the class to supervise the hunt.

3. Distribute the *Scavenger Hunt List* and review the items with students. Encourage students to speculate on possible answers prior to actual schoolyard exploration. Tell them that they will have to think carefully to determine what types of litter fall into each category. Explain that bringing back a description of a natural item is preferable to disturbing some items that should remain untouched.

Have students wear protective gloves. Remind students not to pick up pins, needles, cigarette butts, bandages, and other objects that may injure them. Have students identify the object for #6 on the list without picking it up.

4. Distribute litter bags and gloves to students and take them for a walk around the school grounds, neighborhood or a nearby park, wherever it is safe and convenient. Encourage students to observe litter wherever it occurs and to be prepared to discuss its location and possible origin upon returning to the classroom. Then let students begin their exploration and collection after reminding them not to leave the grounds or wander out of sight of the class. Set a 10-minute time limit and use a whistle or other method to signal the end of the hunt.

5. Return to the classroom and have students discuss and compare the items they collected. Encourage students to hypothesize what will eventually happen to apple cores and orange peels and what will become of soda bottles and glass objects. Ask students what will happen to the resources in the glass, metal, plastic and paper objects if they aren't returned to be recycled. *(They will be wasted.)*

6. Have students hypothesize about why people didn't carry their waste with them until they could dispose of it properly.

Questions for the Class

1. For each item of litter found, ask students to list one way the item was useful to people and one way it can affect the environment if littered on the ground or in the water. Encourage students to recognize the loss of resources when recyclables are not returned for recycling.

2. Erase the definitions from the board and ask students to rewrite them based on their experience.

3. Have students write a short story about one item of litter found on the hunt, discussing WHAT it is made from, WHERE it was found, WHO might have dropped it, WHY someone littered the item, and HOW it came to be where they found it.

Just Do It

Collect litter on your way home from school and dispose of it properly. Pick up three pieces of litter after each recess and discard it in the classroom waste can. If the litter is recyclable, recycle it.

Extension Activities

1. Following the Scavenger Hunt exercise, spend an additional 10 minutes with students sitting in a circle outdoors. Talk about the natural environment and have students observe the sights and sounds of nature (wind, birds, crawling things). Have them experience the objects around them and describe them in terms of texture, color, emotion, etc.

2. Review with the class information on the seven sources of litter from Keep America Beautiful.

Seven Sources of Litter

- Home garbage - Use only trash containers with tight-fitting lids. Paper or plastic bags can be opened by animals. Trash cans without lids or with loose lids can be knocked over by animals, and the wind can move the trash several blocks, or even miles.

- Business trash - Tight, closed lids and even locks are sometimes needed on containers.

- Truckloads - If loads are not tied down, many dangerous materials fall or are blown from the truck. Loose material is blown out of truck beds. Many people don't think about putting on tarps, and some don't know that they are accidentally losing parts of their load. Roads to the dumps are easy to follow because of all the litter along the roadway.

- Construction and demolition sites - Fences around construction sites keep materials from flowing out into the neighborhood. Putting waste materials into proper containers and tarping truck loads keep construction sites clean and construction and demolition materials off our roads.

- Loading docks - Keeping storage bins or dumpster tops closed and the area clean keep this material in place and away from the rest of the neighborhood.

- Motorists - Car litter bags and litter containers at rest areas, gas stations and fast food stores are important to controlling auto littering.

- Pedestrians - Sidewalk litter receptacles and good habits help control this source of litter.

SCAVENGER HUNT LIST

Bring back only discards from people or nature. You can bring back an answer in your head or written on this sheet for items that can't be put in your bag!

☐ 1. a natural food covering

☐ 2. a man-made food covering

☐ 3. a man-made object that came from mineral/rocks

☐ 4. a man-made object that came from mineral/oil

☐ 5. a man-made object that came from plants

☐ 6. something man-made that can cut your finger ***(Be careful not to hurt yourself. Describe it or draw a picture of it.)***

☐ 7. something that is decomposing or decaying

☐ 8. something that could be recycled

☐ 9. something that a worm might like to eat

☐ 10. something hard, something soft, something smooth, something rough

☐ 11. something you could use to make a toy

☐ 12. something that helps a plant grow

☐ 13. something that could hurt an animal

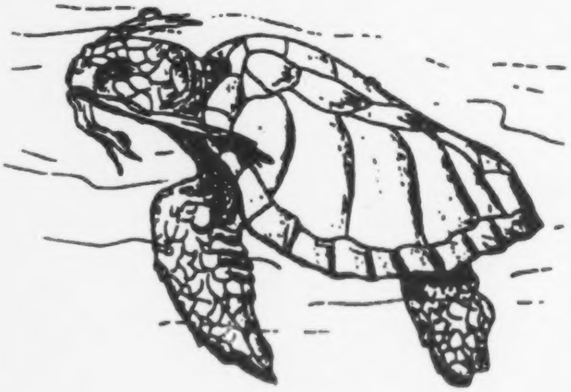
☐ 14. something that would mold

☐ 15. a sign of water, air, noise, or visual pollution

Litter In The Wild

Preparation Time: **Easy-To-Do** Moderate Extensive

Grade: 4 - 5
Focus: How litter affects wildlife
Subject: Social Studies, Math, Science
Materials: *Litter Endangers Wildlife* overheads, pictures from magazines or samples of litter (six-pack rings, fishing line, plastic wrap, plastic bags, gum wrappers, cigarette butts, *Litter In The Wild* worksheets
Teaching Time: Two class periods
Vocabulary: Litter, pollution, endanger



Learning Objective
Students will:

- identify and evaluate ways that litter can endanger wildlife
- identify ways to help reduce these dangers.

Background
Environmental pollution affects all forms of life. Litter exposes wildlife to possible injury, illness, and death.

According to the *1993 Earth Journal*, **pollution** along our coasts and beaches appears to have become the rule rather than the exception.

The International Coastal Cleanup, the world's largest, collected 3.7 million pounds of trash along 4,743 miles (7,633 km) of beach in 1991. Coordinated by the Center for Marine Conservation, the 1991 cleanup enlisted more than 145,000 volunteers in 34 U.S. states and 12 countries.

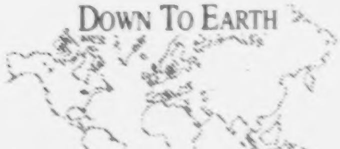
Plastics were the most common debris item found, accounting for about 59 percent of all debris collected.

Six-pack yokes, fishing line, lost buoys and fishing nets have been tossed out carelessly for years. Fishing line often traps the legs, wings and beaks of water birds like geese, herons and pelicans. Some birds need to run short distances to take off when they fly. Fishing line attached to their legs and wings prevents them from doing so; it also interferes with swimming.

Some animals eat **litter**, thinking that it is food. The litter gets caught in their digestive system and they die of starvation or illness. Sometimes fish or birds get caught in the loop of plastic six-pack yokes. They continue to grow, but the ring doesn't stretch.

On land, litter also **endangers** wildlife. Half-open food and soda cans are a problem for animals. Deer and raccoons can cut their mouths on cans, and smaller animals can get their heads stuck inside the cans and starve to death.

Many people are unaware of the injury, suffering and death they cause animals when they throw trash on the ground or into the water.



Fourteen billion pounds of garbage are dumped into the world's oceans every year, most of it in the Northern Hemisphere.

Source: *50 More Things You Can Do To Save The Earth*

Learning Procedure

Day One

1. Write the words "litter," "pollution" and "endanger" on the board. Discuss with students and help them to define each word.

2. Project the overheads, *Litter Endangers Wildlife*. Review the background material that accompanies this lesson, and discuss with the class how litter can harm wildlife on land and in the water.

3. Using litter items, or pictures of potential litter items, have students discuss the potential harm each item could present in the wild.

4. Introduce the term "master scale." Explain to students that this is a method of rating things, and in this case they will be rating the potential harmfulness of litter items in the wild. They will be creating a master scale from one to ten, with ten being the most harmful. See the example.

5. Have students identify the most harmful object. Give it a rating of 10. Have students discuss each item's potential for harm and settle on an agreed upon rate each item. Some items may have the same rating.

6. Ask for volunteers to attach each picture or item to a large cardboard or art paper panel and draw in large numbers to show each item's rating as it is decided.

7. Assign students to look for pictures of items that often become litter and pictures of wildlife that can come in contact with litter and to bring them to class.

Day Two

8. Divide the class into groups of four or five students. Have each group use its pictures to assemble a collage. When the collages are finished, have the students use the agreed upon master scale from the earlier portion of this lesson to rate each piece of litter in their collage. Have students tally a total. *(If students bring in pictures of items that were not rated, have the group assign a rating.)*

9. One by one recognize each group. Have a group representative give the collage total score. Have each group discuss the litter items on their collage and what could be done to prevent it. Write suggestions on the board.

10. Distribute *Litter In The Wild* worksheets and ask students to complete them.

Extension Activities

1. Invite a wildlife expert to join the class for the discussion and to present examples of local littering that harms wildlife.

2. Display the litter collages in a local shopping center during National Wildlife Week, the third week in March.

Example Master Scale

(Have students determine their own scale based on their discussions, this is just a guide. There are no right or wrong ratings.)

Plastic six-pack yokes	10
Monofilament (fishing) line	10
Gum Wrapper	1
Aluminum Can	8
Cigarette Butt	5
Plastic Bag	10
Glass Bottle	6
Polystyrene	8

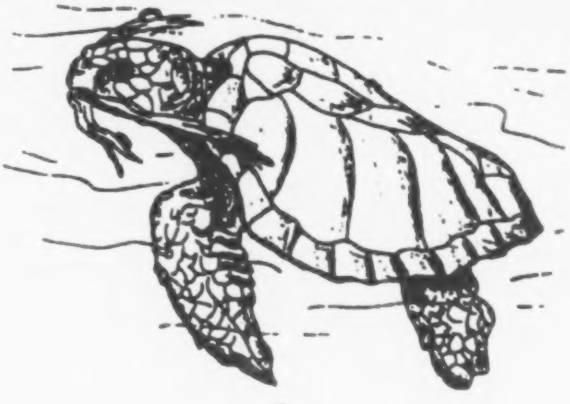
Just Do It

Always take your trash with you when you leave the beach or any activity outdoors.

Name ____

Worksheet

Litter In The Wild



1. Name ways that litter can harm wildlife.

a.____

b.____

c.____

d.____

2. List three things you can do to reduce the litter threat to wildlife.

a.____

b.____

c.____

3. Using this master scale for litter, solve the following word problem:

Example Master Scale

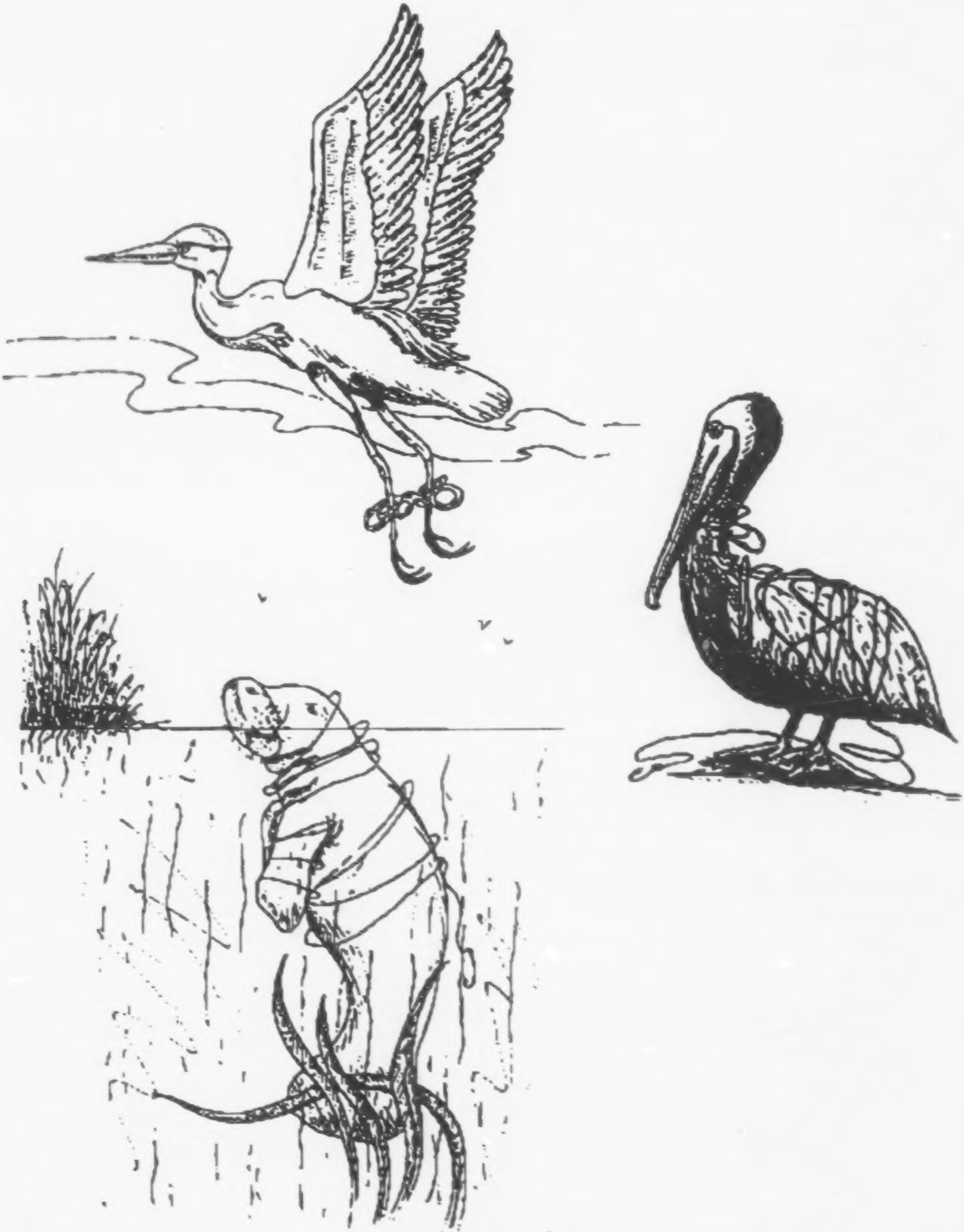
(Have students determine their own scale based on their discussions, this is just a guide. There are no right or wrong ratings.)

Plastic six-pack yokes	10
Monofilament (fishing) line	10
Gum Wrapper	1
Aluminum Can	8
Cigarette Butt	5
Plastic Bag	10
Glass Bottle	6
Polystyrene	8

Six pieces of litter were found on the beach. The total of the ratings equals 45. What are the possible combinations of litter found?

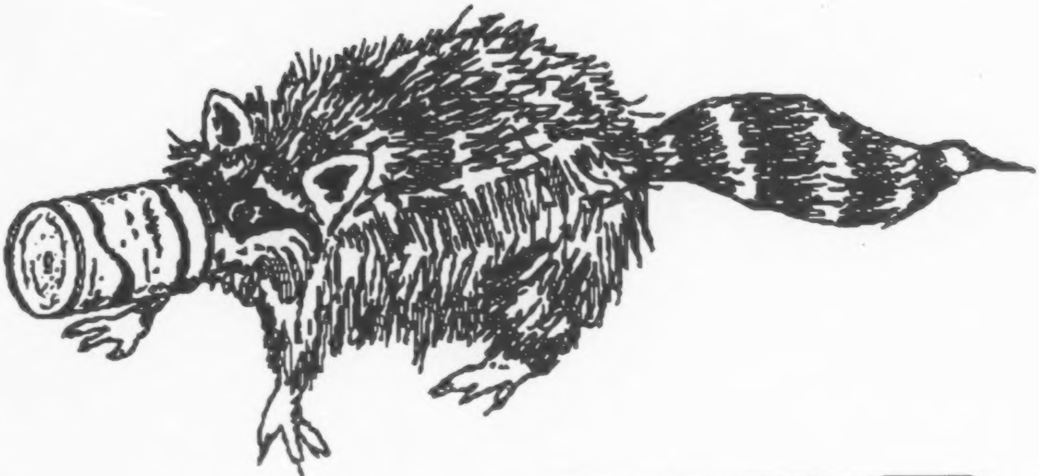
Overhead

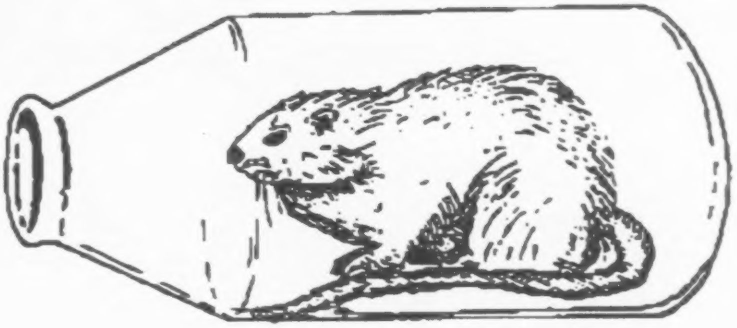
Litter Endangers Wildlife

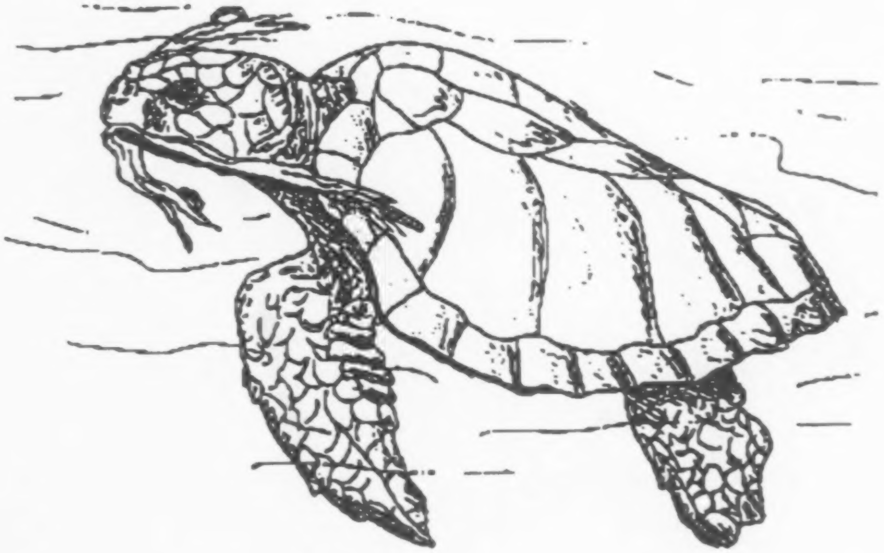


Overhead

Litter Endangers Wildlife







Action for a cleaner tomorrow.

A South Carolina Environmental Curriculum

For more information about South Carolina and the environment, call the South Carolina Department of Health and Environmental Control at 1-800-768-7348.

4.1.5.F

Litter Charades

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 4 – 5

Focus: Litter endangers wildlife

Subject: Social Studies, Science, Language Arts, Art

Materials: *Read More About It* handout, charade cards

Teaching Time: One class period with ongoing review of results and follow-up discussions

Vocabulary: Plastic, litter, entangle, decompose

Learning Objective

Students will:

- recognize some of the environmental hazards of litter.

Background

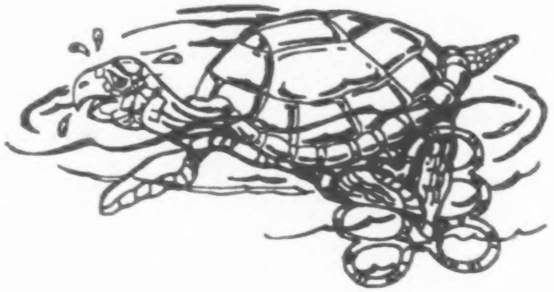
See the Resource section on plastic and landfilling.

Learning Procedure

1. **Ask:** Is plastic **litter** a problem? Discuss why it is important not to litter. *(Besides being unsightly, animals become entangled in and ingest litter, which is harmful.)*

2. Share the attached *Read More About It* information with students. Discuss the effect of plastics on the environment and their harm to aquatic wildlife including fish, mammals, birds and reptiles. How might we begin to solve these problems?

3. After reviewing the different problems caused by litter, play a game of charades. Break the class into groups of two or three. Give each group one of the attached charade cards. Students act out the litter — and other pollution — cause or actions and then its effect on humans, wildlife, and the environment. After each charade has been guessed, have the class discuss possible ways to prevent or solve the problem. *Note: these cards address issues other than just plastic litter. Have students research the impact of other forms of pollution on wildlife or see the Resource Section.*



Question for the Class

What are two things you can do to prevent harm to wildlife from litter?

Extension Activities

1. Write and illustrate a story about a wild creature encountering litter.

2. Select an item often found as litter and have the class use the item to create art. For example, six-pack rings can be used to make great mobiles.

Just Do It

Have the class research South Carolina's Annual Beach Sweep Cleanup, held in the fall.
Call 1-800-851-8899 for information on how to participate.

DOWN TO EARTH

Volunteers for the Center for Marine Conservation picked up 2.5 million pounds (1,134 metric tons) of trash off 3,800 miles (6,115 kilometers) of United States coastline, and a whopping 60 percent of it was plastic.

Source: GreenWatch, Good Housekeeping, 1992

Read More About It!

Information about plastic litter from the Center for Environmental Protection

Every year countless numbers of marine animals are found entangled by fishing line. Sea turtles become entangled in snagged line and, unable to break free, they drown.

Birds even use discarded line for nesting materials. This can create death traps for their young.

It's not just fishing line that causes problems. Fish, birds and other animals have been found entangled in plastic rope, nets and even plastic connector rings used for beverage and motor oil cans. But entanglement is only part of the problem. Some animals – including sea turtles, whales and dolphins – even mistake plastic trash for food, a fatal mistake. One sea turtle was found with 590 feet (180 meters) of heavy duty line in its stomach, and several have been found to eat plastic bags and sheeting. The animals then do not eat because their stomachs are full of plastic, and they starve to death. *—Kathyrn O'Hara*

Information about plastic litter from Aquatic Project Wild

The Cousteau Society estimates that six million tons of litter enter the sea each year. Most of this is the product of merchant ships and the practice of dumping garbage in the sea.

Commercial fishing fleets are estimated to lose nearly 300 million pounds (136,080 tons) of plastic fishing gear in a single year. This plastic netting entangles and kills fish and marine mammals. Scientists estimate that plastics are killing up to a million seabirds and over 100,000 sea mammals a year.

Recently plastics have been found in the stomachs of whales, dolphins, fish, birds and manatees. Leatherback turtles often mistake plastic bags floating in the sea for jellyfish, one of their favorite foods. As plastics accumulate in the intestines of such animals, starvation occurs slowly. Plastic holders for beverage cans, plastic bags and lost or discarded fishing line can all be damaging to wildlife.

Litter Charade Cards

ACTION: **EFFECT:** **SOLUTION:**	**ACTION:** A person throws a hot match on a path or roadside. **EFFECT:** A forest fire starts. **SOLUTION:**
ACTION: A person litters a plastic ring from a soda six pack. **EFFECT:** The plastic ring strangles a duck or a fish. **SOLUTION:**	**ACTION:** A farmer uses dangerous pesticides. **EFFECT:** Rain washes the pesticides off into a stream and fish die. **SOLUTION:**
ACTION: A person burns household trash in a barrel in the backyard. **EFFECT:** Smoke fills the air and pollution increases. **SOLUTION:**	**ACTION:** A person throws a plastic sandwich bag out in the lake. **EFFECT:** A fish thinks the plastic is food, eats it and starves because its digestive track gets blocked. **SOLUTION:**
ACTION: Someone changes his or her automobile oil and dumps it on the ground. **EFFECT:** A person or animal drinks contaminated water and becomes sick. **SOLUTION:**	**ACTION:** Helium balloons are released at a football game. One pops and falls into a lake or river. **EFFECT:** A turtle eats the balloon and dies. **SOLUTION:**
ACTION: A litterer throws a bottle out of a car. **EFFECT:** A person or animal steps on broken glass and cuts its foot. **SOLUTION:**	**ACTION:** A fisherman leaves broken fishing line in the ocean. **EFFECT:** A porpoise becomes entangled in the line. **SOLUTION:**

Action
for a
cleaner tomorrow.

A South Carolina Environmental Curriculum

For more information about South Carolina and the environment, call the South Carolina Department of Health and Environmental Control at 1-800-768-7348.

Look in Your Garbage Can!

Preparation Time: [illegible] **Moderate** Extensive

Grade: 4 - 5
Focus: Garbage awareness
Subject: Math, Social Studies, Science
Materials: Heavy cardboard or construction paper, colored marking pens
Teaching Time: One class period
Vocabulary: Garbage, industrial waste

Learning Objective

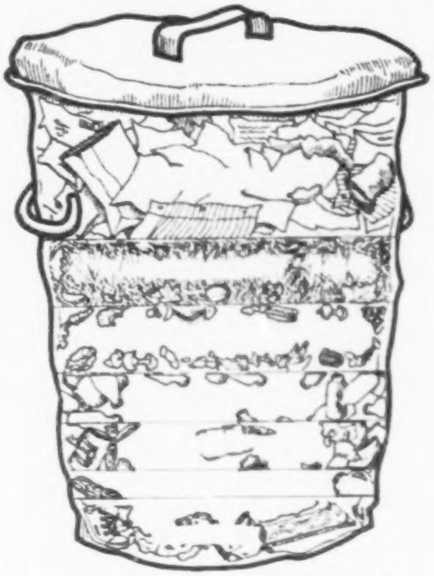
Students will:

- see what the average family of four throws away every day
- discover what steps can be taken to reduce the amount of garbage a family generates by reusing and recycling and by composting yard and food wastes.

Background

How many things will you throw away today? An empty cereal box? Your lunch bag? Some papers from school? When you stop and think about it, you may be surprised at how much trash you toss out.

Each of us throws away more than 1,200 pounds (about 544 kilograms) of trash each year, far more than people in most other countries. In South Carolina, about 80 percent of this garbage ends up in landfills.



In South Carolina on the average, each person is responsible for about 8.5 pounds (3.83 kilograms) of waste daily. This figure includes **industrial** and agricultural wastes. An average of 5.6 pounds (2.52 kilograms) of residential **garbage** (waste collected from the home) is generated per person each day in South Carolina. The average family garbage can contains predictable types and amounts of waste. Much of this waste is unnecessary, some is reusable and recyclable, and some can be used to create nutrient-rich compost.

Up to 84 percent of everything we throw away is recyclable in some way, but today in South Carolina, an average of only 16 percent of our waste is recycled. South Carolina's goal is to recycle 25 percent or one-fourth of our garbage.

Learning Procedure

In this activity, students will examine what is in the average family garbage can according to weight.

1. Using heavy cardboard, cut seven separate pieces to construct a garbage can. Each piece will be sized according to one of the seven categories of waste and will be labeled with a category and percentage

Although only 5 percent of the world's people live in the United States, the nation accounts for 25 percent of world energy consumption.

of garbage by weight. Each piece may be brightly colored. *(See the Garbage Can diagram included with this lesson.)*

2. Ask students to think about what is in their garbage cans. Ask them to name various categories of this waste.

3. Place all seven pieces of your version of the Garbage Can diagram face down on a table. Divide the students into seven groups and have a student from each group choose a piece. Have the student show and read what is on the card and then tape it up on the board. *(As students select pieces they will assemble the whole Garbage Can on the board.)*

In the individual groups, have the students research their selected category of waste. Use the following facts as a guide for each selected garbage category. Some discussion questions are included.

Paper

About 40 percent (4/10ths) by weight of everything we throw away is paper.

- In the United States, we cut down more than 4 billion trees a year to make paper and cardboard for newspapers, magazines, packaging, junk mail, toilet paper, boxes, etc.
- If every American recycled just one-tenth of their newspapers, we would save about 25 million trees a year.
- Recycling of old newspapers reached a record 6.6 million tons in 1992, an increase of 90 percent since 1983.

Paper constitutes fully 50 percent (or about one-half) of the nation's municipal waste *by volume*. Two-thirds of U.S. paper production still ends up in the trash.

Ask: What are some of the things that we throw away that are paper? Some examples are:

- cereal boxes *(open one: if the inside is gray it was probably made from recycled newspaper)*
- newspaper
- magazines
- letters.

Glass

About 7 percent of everything we throw away is glass. (6.6 percent in 1993.)

- Interesting fact: Of the 46 billion bottles and jars produced in 1981, only one in 15 was eventually crushed to bits and melted down along with fresh material to make new jars and bottles.

Examples of some things we throw away that are glass:

- food jars
- household cleaners and toiletry bottles *(i.e. mouthwash containers)*
- beverage containers.

Metal

8.3 percent of everything we throw away is metal.

- Interesting facts: If you buy soft drinks in aluminum cans, chances are better than one-in-two (+50 percent) that your can was made from other cans.
- The time between a can leaving the factory and dropping into the melting furnace once more may be only three months.

Examples of some things we throw away that are metal:

- old household equipment and appliances
- cans (aluminum, tinned and bi-metal)
- metal caps from jars and bottles.

Food Waste

Up to 6.7 percent of everything we throw away is food waste.

- Interesting fact: The world's largest composting pile, the Netherlands' VAM, or Waste Treatment Company, produces approximately 125,000 tons of compost a year. This is sold for farm and garden uses.

Examples of some things we throw away that can easily be used in a compost pile:

- coffee grounds
- egg shells
- nut shells.

Plastic

9.3 percent of everything we throw away is plastic.

- Interesting fact: There are many kinds of plastic. This is one of the reasons plastic is so difficult to recycle. If all plastic containers were made from the same type of plastic, they would be much easier to recycle but this is not practical. Six resins account for 97 percent of the plastics used in packaging.

Examples of some things we throw away that are plastic:

- shampoo and dish-washing soap containers
- plastic milk bottles
- plastic wrap
- produce bags and meat packaging.

Yard Wastes

About 15.9 percent of everything we throw away is yard waste.

- Interesting fact: Compost piles can reach 140 - 160 degrees Fahrenheit in the center. In cold weather, steam will rise from the pile.
- In South Carolina, as of May 27, 1993, yard wastes are banned from being disposed of with regular household waste. Many communities now have composting facilities to handle this waste and turn it into compost that can be sold for garden mulch.

Examples of yard waste that should be composted:

- grass and hedge clippings
- wood ash
- weeds.

Other

About 15.6 percent of everything we throw away does not fall into the other six categories.

Examples of what "other" may be:

- rubber
- textiles (clothing)
- wood.

Questions for the Class

1. List the contents of the average family garbage can.

2. If each person throws away an average of 5.6 pounds of garbage from their household and school every day, how much is each family throwing away each day? Each class?

3. Where does the family garbage go?

4. What are some ways to reduce the amount of garbage being thrown away from each home and school?

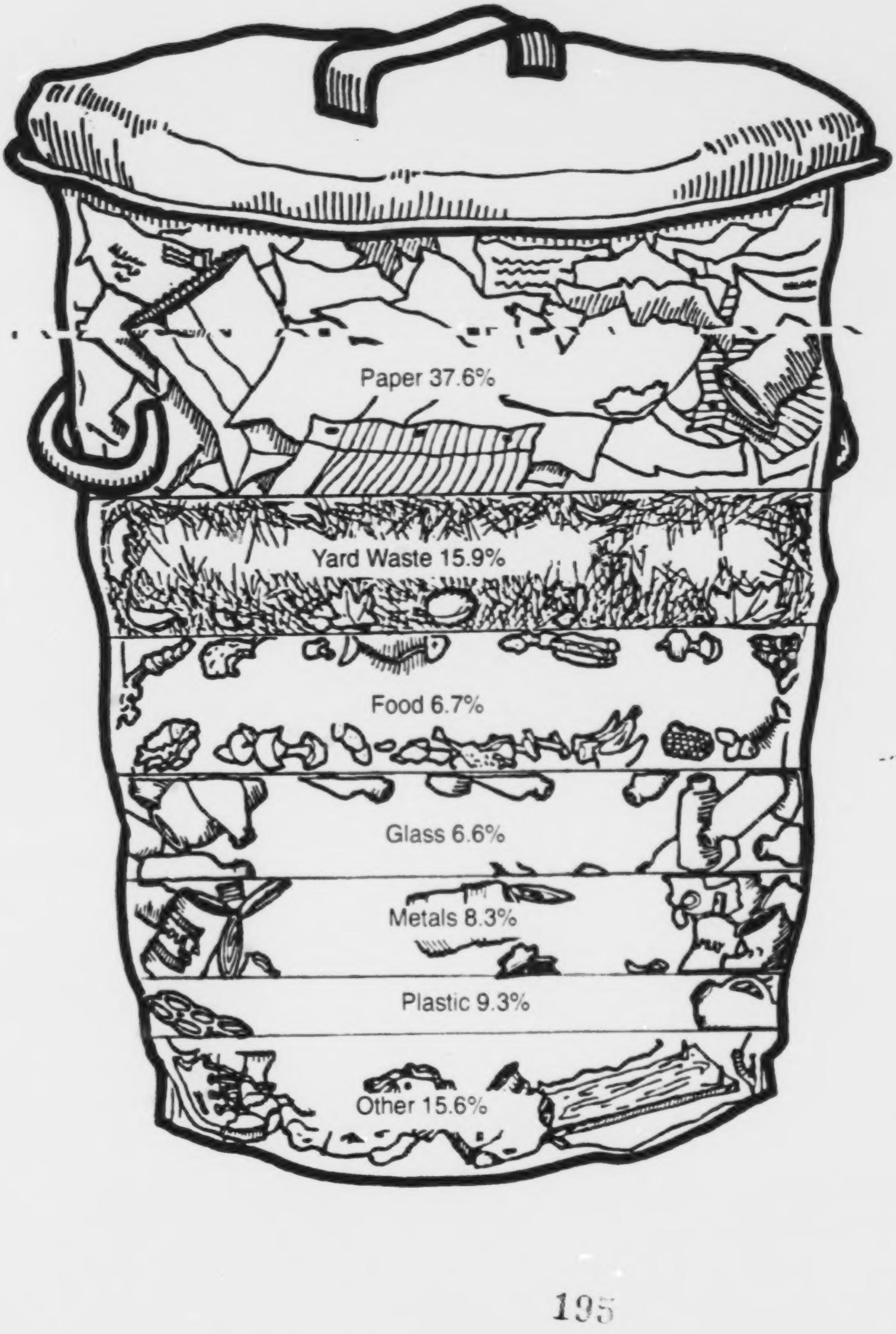
Extension Activities

1. South Carolina has both urban and rural areas. How is the trash different in these areas? How is it the same? How is it disposed of differently? Have students research and discuss.

2. Have students become "Garbologists" for a day. Have them investigate the contents of their family garbage can to discover what our trash tells about us. Write a paragraph about what we eat, what we buy, and our lifestyle.

Just Do It

Go grocery shopping with your family and look for alternatives to products that contain too much garbage. For example, choose cereal packaged in bulk, or drink mixes you make yourself at home instead of beverages in throw-away containers.


Paper 37.6%
Yard Waste 15.9%
Food 6.7%
Glass 6.6%
Metals 8.3%
Plastic 9.3%
Other 15.6%

If It's All The Same To You

Preparation Time: Easy-To-Do Moderate **Extensive**

Grade: 4 - 5

Focus: Household hazardous wastes

Subject: Social Studies, Science, Language Arts, Health

Materials: Samples of safe and hazardous "look-a-like" products (see Teacher Information Sheet for suggestions), *What's in Your House* worksheet (one per student, *Common Household Hazardous Wastes* worksheet, *Home Safe Home* and *Safer Alternatives* handout

Teaching Time: Two class periods

Vocabulary: Household hazardous waste & products, potential, caution, warning, danger, poison, ignitable, toxic, reactive, corrosive, labeling

Learning Objective

Students will:

- define household hazardous waste and products that are classified as hazardous
- develop an awareness of the potential hazards of common household products
- identify places they may be found.

Background

Each year, thousands of young children are accidentally poisoned or severely burned by exposure to medicines, insecticides, drain cleaners, furniture polish, bleaches and other toxic chemicals kept in the home. It is everyone's responsibility to make sure children and pets are not exposed to potentially hazardous substances.

GLASS CLEANER
SPARKLE
Polish

The average home in South Carolina contains 45 products that are potentially hazardous to people, pets and/or the environment. Hazardous household products are stored in the kitchen, bathroom, laundry room, garage, hobby room and virtually every room in the house.

A household hazardous product is any substance that is:

- **ignitable** such as gasoline, oil-based paint, paint thinners, aerosol spray products and degreasers
- **toxic** pesticides and antifreeze
- **corrosive** such as oven cleaners, swimming pool chemicals, toilet bowl cleaners, battery acid and ammonia
- **reactive** such as ammunition and road flares
- otherwise harmful to human health or the environment when improperly stored, handled or disposed.

Labeling household hazardous products helps people, particularly young people, recognize their potential hazard and respond to the product appropriately.

DOWN TO EARTH

The price tag for cleaning up United States hazardous waste sites could be $750 billion over the next 30 years, according to a report issued by the University of Tennessee.

Source: 1993 Environmental Almanac

Learning Procedure

Warning to Teachers: Anytime you discuss or deal with hazardous household materials, exercise extreme caution. Do not let students handle the materials. Keep them locked away when you are not using them in your classroom demonstrations.

Day 1

1. Begin discussion by showing students samples of household hazardous products. *(Bleach, drain opener, furniture oil, paint, many medicines, detergents, rat poison, fertilizers, and moth balls.)*

2. Write the following words on the board: CAUTION, WARNING, DANGER, POISON, POTENTIAL. Ask students to define these words. Accept answers and modify so that definitions are correct and easy to comprehend and remember. Have students write the definitions. For example:

CAUTION	Be careful. The product should be used with care.
WARNING	Implies a stronger risk than caution. Use with added care.
DANGER	Signals that exposure or unsafe use may cause injury, illness, or death.
POISON	Also toxic. A substance that, through its chemical action, usually kills, injures, or impairs a living thing.
POTENTIAL	Capable of developing into reality. A possibility.

3. Write the words "household hazardous products" on the board. Have students develop a definition and then write it down. Tell the class that many home and garden products are potentially dangerous. Tell the class that sometimes words like CAUTION, WARNING, DANGER or POISON appear on a product and can alert us that the product is potentially hazardous.

Make three columns on the board, labeled: HOUSEHOLD PRODUCT, POTENTIAL HAZARD and CATEGORY. Ask students to think of some commonly used household products that can be both helpful and yet potentially hazardous *(furniture polish cleans and shines furniture, but might also cause injuries if ingested or sprayed in the eyes).* Ask students how they would label the products using the four categories of hazard — *CAUTION, WARNING, DANGER or POISON.*

4. Pass out lists of potentially hazardous products, *What's in Your House?* Allow time for students to read. Discuss any products not suggested earlier.

5. Have the class develop a pictorial legend for each of the four categories of household hazardous waste (for example: CAUTION could be a diamond with a C in the middle, WARNING a circle with a W in the middle, DANGER a rectangle with a D in the middle, and POISON a square with a P in the middle. Keep them simple and have the class agree on one set of symbols.) Have students draw the appropriate legend for each category shown on the *What's in Your House?* worksheet.

6. Discuss where various hazardous household products might be found in students' homes. Discuss how the amount of hazardous products used in every house varies and how people vary in their use and storage of potentially hazardous products.

7. Tell students that many accidents in the home can be avoided if products are kept out of reach of children. Ask students to give some examples of how products can be kept out of reach *(high shelf out of climbing range, locked cupboard, secure drawer).*

8. Have students survey their homes for products from *What's in Your House?* worksheet noting what they find and where the products were found. Remind students that these products are dangerous and that this activity should be completed with parental permission and under parental supervision.

Day 2

9. Have students share their findings from the home assignment.

10. Define: TOXIC, REACTIVE, IGNITABLE, and CORROSIVE. Have students complete the *Common Hazardous Wastes* worksheet.

11. Pass out *Home Safe Home* and *Safer Alternatives* to be taken home and shared with family.

Questions for the Class

1. What are the four kinds of hazardous waste?

2. Where should all hazardous materials be stored?

Extension Activities

1. Have students create a household hazardous waste publication that will be made available to the school and community newspapers. The publication should include:
   - a. Typical hazardous products found in homes and institutions (from the lists they compiled.)
   - b. The hazardous waste category of each product and an explanation of the hazard.
   - c. Recommendations for proper disposal of the hazardous waste.
   - d. A non-hazardous alternative for the hazardous products.
   - e. Sources of help and/or information for problems encountered in the use and disposal of hazardous products.

2. Have the students write for household hazardous waste information from the Department of Health and Environmental Control, 2600 Bull Street, Columbia, SC 29201.

3. Invite a county or regional environmental specialist to visit your class and discuss potential environmental risks of common household products.

Just Do It

If you have younger brothers and sisters at home, see to it that all hazardous materials are put away, safely out of reach. Remember, even fingernail polish remover and other common products can be dangerous.

Teacher Information Sheet

Safer Alternatives

PRODUCT	ALTERNATIVE
air fresheners & deodorizers	Open a window or use an exhaust fan. Sprinkle baking soda in odor producing areas or set vinegar out in an open dish. Use scented natural potpourri.
bleach	Use a baking soda and water cleaning solution.
disinfectants	Wash items with soap and water or with borax or sodium carbonate (baking soda) in water.
drain cleaner	Cover drains with screens to prevent clogging. To loosen clogs: Mix 1 cup baking soda, 1 cup salt, 1 cup white vinegar and pour down drain. Wait 15 minutes. Flush drain with boiling water. Use a rubber plunger or a plumber's snake.
flea powder	Bathe animals with pet shampoo containing insect-repellent herbs such as rosemary, rue, eucalyptus and citronella.
floor cleaner/wax	To polish: Mix 1 part thick boiled starch with 1 part soap suds. Rub on floor and polish dry with a clean, soft cloth. To clean: Rub with club soda, scrub well, let soak, wipe clean.
furniture polish	Use olive oil, 100% lemon oil, beeswax, or 2 tsp. lemon oil and 1 pint mineral oil in a spray bottle.
oven cleaner	Wipe charred spills with a non-metallic bristle brush. Scrub baked-on grease and spills with a baking soda, salt and water solution.
paint thinner	Use latex paint and eliminate the need for paint thinner.
paints	Use water-based paint and non-aerosol paints.
spot removers	Use white vinegar or a solution of equal parts of ammonia and water.
toilet bowl cleaner	Use 3 tbs. ammonia, 1 tbs. white vinegar and 3/4 cup water in a clean spray bottle or use a solution of 2 tbs. vinegar in 1 quart water.
pesticides	Garden: Spray plants with a solution of 3 tbs. soap per gallon of water. Spray with pyrethrum (a chrysanthemum-based natural pesticide). Household insect spray: Grind 1 clove garlic and 1 onion. Add 1 tbs. cayenne pepper and 1 quart water. Mix well. Let steep 1 hour and add 1 tbs. liquid soap.

Student Handout

WHAT'S IN YOUR HOUSE?

Hazardous substances can be found in many places in the home. Where would you find the following products? Can you think of other household hazardous substances not mentioned below? If so, write the product on the lines provided.

Caution ☐

MEDICINES ______________
BLEACH ______________
FURNITURE POLISH ______________

BUBBLE BATH ______________
SCOURING POWDER ______________
COSMETICS ______________
______________ ______________
______________ ______________

Danger ☐

OVEN CLEANERS ______________
POOL ACID ______________
PAINT THINNER,
TURPENTINE ______________
CHARCOAL LIGHTER FLUID ______________
GUNS AND AMMUNITION ______________
______________ ______________
______________ ______________
______________ ______________

Poison ☐

SLUG BAIT ______________
TOILET BOWL
CLEANERS ______________
WEED KILLERS ______________
ROACH SPRAY ______________
ANTIFREEZE ______________
ROOM DEODORIZERS ______________
RAT POISON ______________
NO-PEST STRIPS ______________
GLASS & WINDOW
CLEANERS ______________
MOTHBALLS ______________
DRAIN OPENERS ______________
______________ ______________
______________ ______________
______________ ______________

Warning ☐

LAUNDRY DETERGENT ______________
FLOOR POLISH ______________

PET FLEA COLLARS ______________
DISINFECTANT CLEANERS ______________
______________ ______________
______________ ______________
______________ ______________

Common Household Hazardous Wastes

Many of the items we use every day can become hazardous wastes if they are disposed of improperly. Hazardous wastes can be classified as being *ignitable* if they can catch on fire and burn; *corrosive* if they eat away the containers which hold them; *reactive* if they can explode; and *toxic* if they are poisonous. Of course, some wastes can be in more than one category. For example, fingernail polish remover is both ignitable and toxic.

DIRECTIONS: Place an **I** if the object is an *ignitable*, **C** if it is *corrosive*, **R** if it is *reactive*, or **T** if it is *toxic*. Some items may have more than one letter. Some items have no letters.

_______ 1. transistor battery

_______ 2. car battery

_______ 3. shaving cream can

_______ 4. gasoline

_______ 5. empty spray paint can

_______ 6. drain cleaner

_______ 7. empty insecticide spray can

_______ 8. unused matches

_______ 9. used match

_______ 10. unused drugs and medications

_______ 11. unused fertilizer

_______ 12. broken thermometer (silver-colored only)

_______ 13. rug spot remover

_______ 14. lacquer

_______ 15. flea killer collar for pets

_______ 16. newspaper

_______ 17. paper

_______ 18. used spray deodorant can

_______ 19. hydrochloric acid from school lab

_______ 20. flashlight battery

Common Household Hazardous Wastes

Many of the items we use every day can become hazardous wastes if they are disposed of improperly. Hazardous wastes can be classified as being *ignitable* if they can catch on fire and burn; *corrosive* if they eat away the containers which hold them; *reactive* if they can explode; and *toxic* if they are poisonous. Of course, some wastes can be in more than one category. For example, fingernail polish remover is both ignitable and toxic.

DIRECTIONS: Place an **I** if the object is an *ignitable*, **C** if it is *corrosive*, **R** if it is *reactive*, or **T** if it is *toxic*. Some items may have more than one letter. Some items have no letters.

C, T	1.	transistor battery
C, T	2.	car battery
R	3.	shaving cream can
T, I	4.	gasoline
R	5.	empty spray paint can
C, T	6.	drain cleaner
R, T	7.	empty insecticide spray can
R, I	8.	unused matches
I	9.	used match
T	10.	unused drugs and medications
R, T, I	11.	unused fertilizer
T	12.	broken thermometer (silver-colored only)
T	13.	rug spot remover
I, T	14.	lacquer
T	15.	flea killer collar for pets
T	16.	newspaper
	17.	paper
R	18.	used spray deodorant can
C, T	19.	hydrochloric acid from school lab
C, T	20.	flashlight battery

STUDENT SHEET

Home Safe Home

Do you, or someone else in your home, ever use detergents, nail polish remover, gasoline, hair spray, paint or bleach?

These products — and many more that are commonly found in our homes — can be toxic, reactive, ignitable or corrosive!

SPARKLE
GLASS CLEANER
WITH AMMONIA
BUG-
Furniture Polish

A few guidelines will help you use chemical products safely in your home.

1. **Use a Nonhazardous Product.** (Choose products that are biodegradable or low in phosphate.)
2. **Read Labels Carefully.** (Know what you are buying.)
3. **Buy Only What You Need.** (Reduce the amount to be discarded.)
4. **Do Not Mix Bleach and Ammonia.** (Reaction products can be toxic!)
5. **Keep Labels on the Containers.** (Keep this important information available.)
6. **Do Not Store Products in Plastic Containers.** (Some chemicals react with plastic materials. Never store chemicals in old food containers)
7. **Do Not Reuse Chemical Product Containers.** (Many chemicals leave residue in their container.)

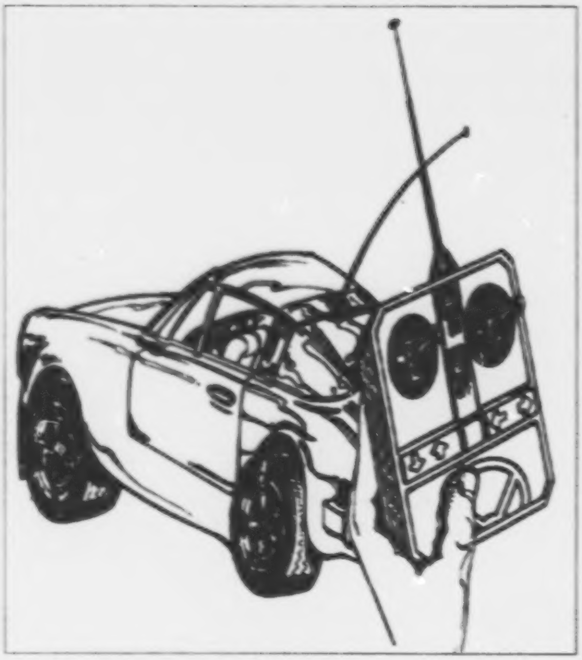
Do you, or someone else in your home, ever throw away pesticides, oven cleaners, car batteries, hair dyes, medicines or waxes?

Some products can contaminate our water resources (including drinking water), our soil and the air we breathe.
Dispose of chemical products properly.

Batteries

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 4 - 5
Focus: Batteries
Subject: Science, Art, Physical Education, Economics
Materials: Magazines, examples of household hazardous products, nutritious treats, area cards (see Step #4 of Learning Procedure.)
Teaching Time: One class period
Vocabulary: Recharge, toxic, hazardous, alkaline, zinc, cadmium, mercury, alternatives



Learning Objective

Students will:

- identify many uses for batteries
- understand the various ways of dealing with used batteries.

Background

Batteries convert chemical energy into electrical energy. The basic battery cell consists of a positive and a negative electrode and an electrolyte, through which the electrical current passes. Primary dry cell batteries *(most common household batteries)* must be disposed after they are used, while the chemical reaction in secondary wet cell batteries (car batteries) can be reversed so the batteries can be recharged and used again.

The South Carolina Solid Waste Policy and Management Act bans the disposal of car and boat batteries from landfills as of May 27, 1992. Most automotive repair shops accept these lead-acid batteries for recycling.

The average American family uses 32 dry cell batteries annually in toys, flashlights, hearing aids, tape recorders, radios, cameras, calculators, and other common household items. In addition to small amounts of copper, zinc, manganese, nickel, and lithium, batteries use:

- 25% of the cadmium
- 45% of mercury and
- 66% of the lead produced in this country.

Once in the waste stream, batteries threaten our environment in two ways. As batteries break apart in landfills or dumps, heavy metals leach into ground and surface water.

If incinerated, these metals cannot be destroyed and are either released as particulates into the atmosphere or trapped in the incinerator ash and

DOWN TO EARTH

Japan uses far less energy than most other industrialized nations — less than half as much per capita as the United States.

Source: 1993 Environmental Almanac

landfilled, where they are a potential contaminate of water sources.

There are safer **alternatives** to adding batteries to our residential waste stream. Although technologies and markets are limited, some batteries can be recycled. Currently, the most easily recycled are the button cell batteries used in hearing aids and cameras. Other batteries that cannot be recycled should still be separated out of the trash and saved for household **hazardous** waste collection programs.

Batteries are a common product that many people do not realize should not be put in a landfill.

Recycling batteries is gaining in popularity as more options become available. In the recycling process, mercury is recovered from some batteries by baking them until the compounds break down, the **mercury** is released as a vapor, trapped and converted back to a liquid. Another method breaks down silver and mercury batteries through heating, dissolves them in acids, precipitates out the silver, and removes the mercury through electrolysis. Other technologies for recovering **cadmium** and **alkaline** from batteries have been developed in Europe and Japan but are not available in this country.

Car batteries are easily recyclable because they are easily identifiable and have a high lead content. Automotive centers are required take back and properly dispose of old car batteries, that can no longer be recharged, when their customers buy new ones. In South Carolina, car and truck batteries carry a $2 per battery fee that funds special disposal.

Rechargeable NiCad batteries, made of nickel and cadmium, are an alternative to the more common household dry cells. Technology is improving rapidly and new types of rechargeable batteries are being introduced. Not all products recommend using rechargeable batteries. Consumers should consider this when making purchases.

Learning Procedure
Note: This activity requires some space for moving around. You may want to hold this activity in a gym or outdoors and save the discussions for the classroom.

1. Cut out pictures from magazines or catalogs of items "run" by batteries. Glue these onto index cards. *(Either let the students do this or have them prepared ahead of time.)*

2. Discuss the pictures of battery-powered products. Consensus by the group is nice but not required.
   - What products do we need to use to help us stay alive (absolutely critical to life)?
   - What products do we need to make our world safer or cleaner?
   - What products do we use to make our lives easier, to save time, provide power to do a difficult job?
   - What products do we use for play or recreation?
   - What products could be operated with a power source other than batteries which get "thrown away" when they are spent. *(Solar powered calculators, power cords used instead of batteries)*

3. Divide the students into two teams. *(Duracells vs. Energizers?)* Each team will have a "contact point" who will be the spokesperson for the team.

4. Begin by telling the teams that they will take turns acting out items that are run by batteries. One person from the first team will draw a card and act out the item on the card for the opposite team to guess. The guessing team will discuss among themselves what they think the item is. The team's "contact point" will give the answer. *(This eliminates the whole team blurting out many answers.)* If they are correct, they score a point. If not, the other team can receive the point if their "contact point" gives the correct answer.

The game continues with teams taking turns and accumulating points. *(Predetermine a time limit.)*

5. Now tell students that they are to imagine themselves as batteries. Some students will be standard non-rechargeables and others will be rechargeable. They will "run" *(jog or march in place)* until they feel run down. Four areas of the room – you may have students make a sign for each of these with an illustration – will be designated:

- the landfill
- the recharge center *(an area with a place to sit and have refreshments)*
- the battery-in-use center *(an area large enough for students to jog in place)*
- the battery-at-rest center *(an area for sitting).*

Explain to the class that batteries have varying lengths of "life." Students will become batteries "in use" when they expend quiet energy marching or jogging in place at the battery-in-use center.

After a few minutes, the batteries will begin to weaken. When they are weak, the non-rechargeables will go to the at-rest center, where they may sit quietly. The rechargeables will have a choice.

Rechargeable batteries may be recharged by going to the recharge center *(where drink and/or refreshment will be provided)* or they may choose to go to the at-rest center with the non-rechargeable batteries to rest for one minute.

After one minute have all batteries return to the in-use center where they will resume expending their energy.

After a few minutes, the non-rechargeable batteries will go to the at-rest center and the rechargeable batteries can choose to be recharged or rested.

Again, after a minute all batteries return to the in-use center for more energy use.

Continue until the non-rechargeable batteries are finally "run down" and must go to the landfill where they will lie down and remain for hundreds of years. Explain that rechargeables can stay in use for years.

Have all batteries go to the battery-at-rest center where they will sit quietly for the following discussion:

- How did you feel after several minutes of being used?
- How did you feel after you had a rest or refreshment?
- How did you feel: 1) as a non-rechargeable battery? 2) when you were told you had to remain in the landfill for hundreds of years? What do YOU do with run down batteries? *(Do you toss them away so they end up in a landfill or do you recharge them?)*
- Can all batteries be recharged? *(Only designated rechargeable batteries can be recharged.)*
- What happens to batteries left in a landfill? Will the chemicals harm the environment? *(Most alkaline batteries contain mercury and cadmium, highly toxic substances.)*

Tell students that landfills must be carefully prepared so that harmful substances such as battery chemicals cannot seep down into the groundwater underneath the landfill. *(They must be lined with clay and plastic. See the Resource Section for more information on South Carolina's landfills.)*

- What could you do to prevent battery chemicals from getting into a landfill? *(Buy rechargeable or non-toxic batteries, and dispose of batteries on toxic waste clean-up days. Use electricity whenever possible instead of batteries.)*

6. Ask the class to think about this question: "What products do you feel are so important you will continue to use them with batteries that you may have to store for a long time because you can't put them in the garbage?"

Extension Activities

1. Together, come up with ways to tell as many people as possible about the importance of not throwing batteries in the garbage. Can you find a group of people to tell? Could students write notes of their own to bring home? Could students make up a song or a rap to send to the local media? Make a pledge to find at least three different people to tell about the importance of not throwing batteries and other hazardous materials in the garbage.

2. Which are more economical over time: regular batteries or rechargeables? Have students discuss this and prepare a report on their findings. For this exercise, have students select a battery-powered toy. For the toy selected, compare the original purchase price of regular, disposable batteries with the original purchase price of rechargeable batteries and its recharger. Estimate the number of sets of regular, disposable batteries they would need to enjoy the toy for one year. (The teacher will have to make some assumptions for the students about use and battery life. For example, a portable radio may use a set of batteries each week, while a battery-operated doll may use one set every six months.)
Use the following formula:

(Price of regular batteries per set)
x (number of sets used in one year)
Cost of annual battery use for this toy

Compare to
(Price of rechargeable batteries per set)
+ (Cost of recharger)
Cost of annual battery use for this toy

Ask: Is cost the only consideration in selecting batteries? Discuss convenience, cost of electricity to use recharger, responsibility to the environment, potential for using same recharger for other sets of batteries for other toys, reliability and quality of rechargeable batteries (does a recharged battery last as long as a regular battery?), etc.

3. Have students write for the latest information on rechargeable batteries.

Just Do It

Plug it in! Use the cord to your boom box or radio whenever possible. This means you don't use as many batteries.

Hauling It Away

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 4 - 5
Focus: Costs associated with managing waste
Subject: Science, Social Studies, Math
Materials: This lesson uses guest speakers
Teaching Time: Several class periods
Vocabulary: Waste manager, custodian, landfill

Learning Objective

Students will:

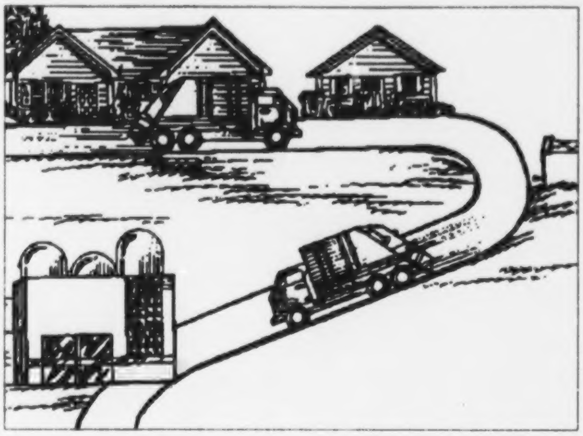
- understand that their trash has to go somewhere
- see that there are limited disposal options
- examine some of the problems of managing so much waste.

Background

Collecting, transporting and disposing of waste are expensive. We are running out of places to take waste and building new places is very expensive.

South Carolina has about 39 permitted municipal solid waste **landfills** and many of these will close over the next few years because they do not meet state and federal environmental standards. Currently only eight meet the new federal guidelines. Other landfills will fill up and close.

Building new landfills is expensive, and this is a cost and concern all citizens share. (See the Resource section for more information on South Carolina's landfills/incinerators.)



Learning Procedure

1. Invite the school **custodian** and **waste manager** to class. *Before their visit*, have the class develop a list of questions to ask, such as:
   - How often is trash picked up?
   - What is the cost of removal?
   - Has that cost changed recently? Why?
   - How much trash is produced each week?
   - What is the composition of the trash?
   - What has the school done to reduce the amount of garbage it produces?
   - What can students do to help?

2. Find out about local waste hauling and management businesses. How many are there? How many residents and businesses do they serve? If possible, ask a local waste hauler to come talk to the class. Some questions to ask the waste hauler are:
   - How many trucks do you own/operate?
   - What kind of trucks are they?
   - How much does that kind of equipment cost?
   - Why is the equipment designed the way it is?
   - How many truckloads of trash do you collect each day?

DOWN TO EARTH

Australia generates more municipal waste per capita than any other country on earth.

Source: 1993 Environmental Almanac

- How is the refuse measured? In tons or cubic feet? (Weight vs. Volume)
- How many houses and or businesses do you collect from each day, week and month?
- Where is the trash taken?
- How many miles do you cover each day? Each year?
- Would you ever consider operating a recycling curbside service? Why or why not? What would it involve?

3. Interview someone or invite a guest speaker to visit the class to discuss voluntary recycling programs or recycling businesses in your area.

4. On the basis of the interviews, have the class discuss the costs involved in collecting and disposing of waste. Include equipment, mileage, salaries, etc. incurred in a waste hauling business.

5. Discuss the reasons waste haulers may or may not be interested in curbside recycling. What added expenses would there be to their businesses? Who would pay these costs?

6. Discuss the differences between city and rural disposal services. Most urban areas have curbside pick up while many rural areas have drop-off sites where people take their garbage. *(Curbside pick up is only economical in highly populated areas where one truck can serve many households in a short amount of time. In rural areas, manpower and transportation costs make curbside pick up too expensive to be practical. In South Carolina, this varies on a county-by-county basis. Explain to students that these economic factors also have a direct influence on why a county may choose to implement a drop-off recycling program as opposed to offering curbside recycling pick up.)*

7. In most areas, people pay a municipality or county government for garbage disposal service.This is a flat fee where everyone pays the same amount regardless of the amount of trash thrown away. **Ask:** How would you change your habits if you had to pay separately for each bag of trash you threw away? (Some areas of South Carolina are experimenting with a system that charges households by the pound for garbage disposal. Specially equipped trucks weigh the trash as it is picked up from the curb; a computer records the weight and bills the resident.)

Extension Activity

Take a guided tour of your local landfill. Is it a dump or is it a state-of-the-art, lined landfill? See the Resource section on landfills for more information on the differences in landfill construction.

Just Do It

When you are considering a purchase, consider the resulting garbage. Is the trouble, mess or expense of getting rid of the garbage worth buying the product? Are there better alternatives?

Making A Simulated Landfill

Preparation Time: Easy-To-Do Moderate **Extensive**

Grade: 4-5

Focus: Distinguish between a dump, a landfill, a sanitary landfill, and a compost pile

Subject: Science, Language Arts

Materials: 3 shoe boxes, 1 milk jug, scissors, organic and inorganic items, soil, water, plastic wrap or garbage bags, twist-ties, landfill diagram

Teaching Time: Ongoing

Vocabulary: Open dump, sanitary landfill, contaminant, leachate, renewable resource, nonrenewable resource, organic, inorganic, biodegradable, compost pile

Prerequisites: Basic lesson on solid waste

Learning Objective

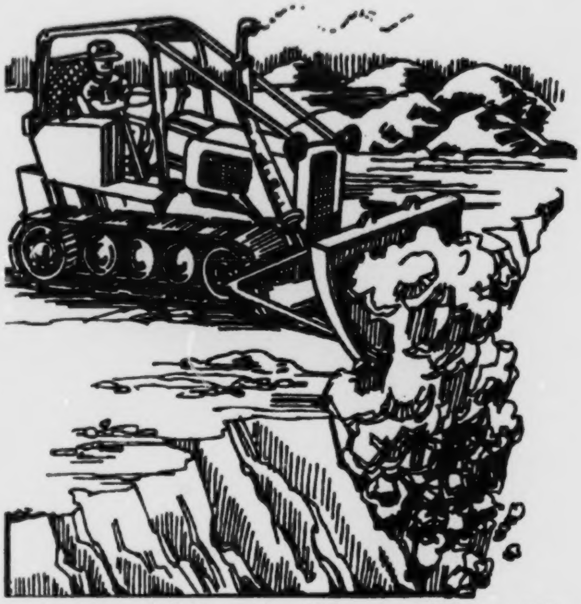
Students will:

- understand the difference between a dump, a landfill *(yesterday's technology)* today's engineered sanitary landfill, and a compost pile
- understand the reason why products do not biodegrade easily in a sanitary landfill.

Background

As the hazards of **open dumping** – just throwing trash in large open areas or pits – have become better known, dumping garbage has been made illegal. In South Carolina, there are laws against dumping that carry stiff penalties and fines, up to $1,000 – even imprisonment. For more information on landfills, see the Resource section.

Landfills, such as local county landfills and municipal landfills are also regulated by law. In South Carolina, there are about 39 permitted municipal solid waste landfills.



There several different landfill types. Early landfills were little more than just organized open dumps. All types of waste were disposed of together, often with dangerous results for the environment. Little was done to protect landfill **leachate** – the liquid that accumulates at the bottom of a pile of waste – from entering the ground and groundwater systems. Many of these landfills are pollution problems today and are having to be dug up and cleaned up. This is very expensive.

Modern landfills – or **sanitary landfills** – are designed to protect the environment and public health by keeping wastes from seeping out of the landfill and into our soil and water.

There are strict rules which characterize a sanitary landfill. Open burning is not allowed. Wastes are spread out, compacted, and frequently covered with several inches of soil to reduce odor and to control litter, insects, and rodents.

DOWN TO EARTH

Large landfills generate enough methane gas to sell as energy. About 100 of the 10,000 landfills in the United States sell landfill gas.

Source: "Garbage In, Nothing Out," *Recycling Today* magazine

Sanitary landfills are constructed with heavy plastic and clay liners that are designed to prevent any of the liquid contents of the landfill from leaking out. The leachate that settles at the bottom of landfill waste is collected in pipe systems, prevented from entering our soil and water and is treated. Pipes also allow methane gasses that form within landfill waste to be released or recovered without causing dangerous explosions.

When landfill cells, or sections are filled, they are capped and sealed.

Sanitary landfills meeting today's tough standards of environmental protection are expensive to build. Many landfills that do not meet requirements are being forced to close. Overall, the number of landfills in this country is getting smaller. However, the size of the new landfills is getting larger. The estimated cost of building and maintaining a landfill that meets EPA requirements is nearly $125 million.

The Myth of Biodegradability in the Landfill.
We used to think that after we discarded trash and it was hauled to the landfill that parts of it would eventually **biodegrade** – that is, it would rot and disappear completely. But it just doesn't happen that way.

That's not to say that many of the contents of our trash can't biodegrade. In a sense, everything in the world is biodegradable. Given enough *time, air, sunlight*, and other elements, your family's house and possessions would all break down and wear away ... eventually. It would take thousands or even millions of years for this to occur.

But when things are buried in a modern, sanitary landfill, where there is little if any air or sunlight, *things do not break down easily*. In fact, burying things in a landfill tends to *preserve* trash rather than eliminate it. This is because landfills have systems of protective liners engineered to keep harmful leachate from **contaminating** the ground and entering our water systems. These liners and covers of clay and soil prevent the biodegrading process from occurring. Because landfills are collections of trash that may contain substances that can harm the earth, sanitary landfill contents are sealed up tightly.

Counting on the trash you throw away to biodegrade is a myth. However, if you dispose of items that can easily biodegrade, such as food waste and yard waste, in a disposal system *intended* for biodegradation, such as a **compost pile,** it will biodegrade quickly.

Learning Procedure
Note: You may find that the best placement of your simulated landfills is outdoors. Be careful to select an area of the playground that is out of high traffic areas so that your experiment will not be disturbed. Also notify the groundskeeping staff so that they will not throw your project away. The open dump simulated in the shoe box will make a mess and the box itself may breakdown. This is the point of the exercise. Open dumps are messy and unsightly, and provide no protective layer between the trash and the ground. The same is true for the landfill model.

1. Divide the class in to four groups. Each group will be responsible for creating one type of disposal system – an open dump, landfill, sanitary landfill, or compost pile.

Making an Open Dump
A. Have the group assemble a variety of **organic** and **inorganic** items for disposal. Include items such as plastic containers, metal screws, newspaper, and food waste. *(Use items such as orange peels to prevent attracting pests.)*
B. Have students create a list of the items.
C. Have students take a cardboard (not plastic) shoebox (without a top) and label it, "Open Dump," then take it outside to an area that will remain undisturbed. Cover the bottom of the box with about three inches of soil and pack the soil down. Then heap the wastes in. Sprinkle with water. Place the Open Dump on a plastic garbage bag that has been spread open. Every other day, sprinkle with about a half a cup of water. Leave the dump open to the sun and air.

Making a Landfill

A. Have the group assemble a variety of organic and inorganic items for disposal. Include items such as plastic containers, metal screws, newspaper, and food waste. *(Use items such as orange peels to prevent attracting pests.)*

B. Have students create a list of the items.

C. Have students take a cardboard box about the size of a large shoebox (without a top) and label it, **Landfill**. Cover the bottom of the box with about three inches of soil and pack the soil down. Then heap in half of the wastes. Add another layer of soil and garbage, and then top with a layer of soil several inches thick. Place the box landfill in a plastic garbage bag, sprinkle with water, and seal with a bread tie. Take the landfill outside where it can remain undisturbed. Every other day open the landfill to let in air, and sprinkle it with about a half a cup of water and reseal the plastic bag.

Making a Sanitary Landfill

A. Have the group assemble a variety of organic and inorganic items for disposal. Include items such as plastic containers, metal screws, newspaper, and food waste. *(Use items such as orange peels to prevent attracting pests.)*

B. Have students create a list of the items.

C. Have students take a heavy plastic gallon milk jug and cut three quarters of the way around it to create a large opening. Label the milk jug, "Sanitary Landfill." The heavy plastic of the milk jug represents one of the landfill's liners. Cover the bottom of the milk jug with a heavy plastic garbage bag to represent additional layers of protection. Add about two inches of soil and pack the soil down. Then heap in half of the wastes. Add another layer of soil and garbage, and then top with a layer of soil several inches thick. Take heavy tape and seal the top of the milk jug back on tightly. Place the "Sanitary Landfill" milk jug in another plastic garbage bag and seal with a bread tie. Take the landfill outside where it can remain undisturbed. Do not add water or open except to observe.

Making a Compost Pile

A. Have the group assemble a variety of *organic items only* for disposal. Include items such as orange and apple peels, leaves, and grass clippings to prevent attracting pests.

B. Have students create a list of the items.

C. Have students take a box and line it with a plastic bag. Then have students add alternating layers of soil and organic material. Top off with a layer of soil. Add about one cup of water. Place the box inside another plastic bag and tie the bag with a bread tie. Every other day have students open the plastic bag and sprinkle it with about a half-a-cup of water. Contents should be moist, not soaked. Every other day have students mix the contents of the box to let in air.

Learning Procedure (continued)

2. After 20 days have students reexamine their disposal systems and observe what has happened.
3. Discuss the condition of the various kinds of waste. Discuss biodegradability. Discuss the differences between the simulated landfill and real landfills. Discuss what happened to the water in their disposal systems.

Questions for the Class

1. What would happen if dangerous wastes were thrown into the open dump, the landfill, the sanitary landfill? Discuss the potential environmental problems associated with mixed waste in landfills.
2. How is composting effective in reducing the amount of waste that might otherwise end up in a sanitary landfill?

Just Do It

Yard wastes do not belong in the landfill! Write to local community or county leaders to find out if there are yard waste composting facilities in your area. If facilities are available, find out what you can do to encourage people in your area to use them. Find out how waste is accepted. Does the county pick up yard wastes? Or do people need to take their yard wastes to a certain location for composting? If facilities are not in your area, request them!

Layers of the Landfill

Today's sanitary landfill is engineered to protect public health and the environment.

Subtitle D of the Resource Conservation and Recovery Act establishes standards that municipal landfills must meet. A Subtitle D Landfill is layered like this ↘

Top Cap - The top cap of a landfill must be covered with:

- 2 ft. (61cm) thick soil cover
- Drainage layer
- Flexible membrane layer of 60 mil HDPE plastic*
- 18 inches (45.7 cm) minimum clay liner (1×10^{-5} cm/sec max)
- Gas management layer

Waste Cells with operational cover

Bottom Liner - The landfill must have a protective bottom liner system that includes:

- 2 ft. (61 cm) protective layer of soil
- Leachate collection system
- Flexible membrane liner (60 mil HDPE plastic*)
- 2 ft. (61cm) clay liner (1×10^{-7} cm/sec**)

South Carolina ...

- Landfills about 80 percent of its solid waste.
- Has about 39 permitted municipal solid waste landfills.

* Other, similar materials may be substituted for HDPE.

** Refers to the permeability, or speed in which liquids can seep, of the clay. This number means that liquids seep very slowly or hardly at all.

Counting Our Resources

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 4 – 5
Focus: Natural resources, recycling
Subject: Science, Language Arts, Social Studies
Materials: Transparency of *Glass Manufacturing* and *Paper Manufacturing*, scrap paper
Teaching Time: two to three class periods
Vocabulary: Natural resource, nonrenewable, embedded energy, direct energy, cullet, recycle

Learning Objectives

Students will:

- identify the raw materials used in manufacturing glass and paper
- recognize that supply and demand influences production decisions and resource availability
- recall the benefits of recycling.

Background

According to the Environmental Protection Agency (EPA), the United States will bury or burn the following materials in the year 2000:

- 11.4 million tons of newsprint
- 16.2 million tons of corrugated cardboard
- 10.8 million tons of glass packaging
- 8.2 million tons of plastic packaging
- 1.5 million tons of aluminum packaging.

If those 48.1 million tons were **recycled** instead, the equivalent of 10.1 billion gallons (38,229,000 kl) of gasoline would be saved. That is enough gasoline to power 15.4 million cars for one year (assuming 18.3 mpg and 12,000 miles (19,312 km) driven per year.) Additionally, the use of recycled materials results in the reduction of water use, water pollution, air pollution, and energy consumption. Yet, the United States only recycles about 14 percent of the approximately 280 million tons of garbage it generates each year.

The energy used to manufacture a product is called **direct energy**. There is another type of energy involved. The energy it takes to transport, distribute, use, and dispose of a product is called **embedded energy**. Both embedded and direct energy costs can be greatly reduced by recycling.

Learning Procedure

1. In this exercise, students will examine resource, energy and waste involved in making glass and paper. Display the following words on the board or overhead:

sand
lime
mining wastes
energy
embedded energy
soda ash
feldspar
salt cake
trees
cullet (crushed glass)

DOWN TO EARTH

92.5 percent of the United States' energy consumption is from nonrenewable resources.

Source: 1993 Earth Journal

water
water pollution
glass jars
computer paper
wood wastes
air pollution
waste byproducts
newspaper
drawing paper

* Explain to students that these items represent some of the **natural resources**, energy, and waste involved in making wood and glass products.

2. Assign students one word each. Provide them with a large piece of scrap paper and direct them to write their word large enough to be seen by the class. If there are more students than words, assign a several of them "energy," "embedded energy," and "waste by-products." Several students could represent various glass or aluminum products as well. Make one more sign for later use, marked "landfill."

3. Display the *Glass Manufacturing* transparency and discuss the process and resources used for making glass. Have students stand when their resource or product is discussed. Tell students that making glass from recycled glass saves 8 to 32 percent of the energy and resources needed to make glass from soda ash, sand and lime. Review the resources used and the product manufactured by this group. Point out the **nonrenewable** resources used by this group. *(sand, soda, lime, energy)* Also explain that producing one ton of glass uses 15.2 million Btus of energy, and creates 384 pounds (174 kg) of mining wastes and eight pounds (3.6 kg) of air pollutants.

4. Repeat the procedure for *Paper Manufacturing*. Tell students that the energy savings in recycling paper is 30 to 55 percent. Review resources, energy, and wastes involved.

5. Have students act out the processes in mini-dramas. "Energy" may want to help get some of the materials mined, shipped and transported. Embedded energy may join the group during the manufacturing and recycling processes. Set up scenarios where the community demands more products and have the resources for those products move to one side of the room, making less available to manufacture the other materials, particularly energy. **Ask:** How does a shortage of resources affect what can be manufactured? Students may substitute recycled materials for the limited resources; this would reduce the energy demands as well. *(For example: embedded energy and glass jars could be used in place of energy, sand, etc., when the community wants more glass products.)*

6. Separate students into nonrenewable and renewable groups. **Ask:** What would happen if all the limited resources were used up? How would this affect production? What would happen if the community demanded more products that require nonrenewable resources? Have students decide what could be done to convince people to use less of those products. *(television, radio and newspaper announcements telling people to reduce, reuse and recycle)*

7. Designate an area of the classroom as the landfill. One by one, discard each group and its energy/embedded energy components into the landfill. **Ask:** How did they feel being thrown away after their process was finished? Why is it harmful to throw out nonrenewable resources? How did it feel to throw out so much energy?

8. Have students decide what the community should do to preserve the environment and conserve resources and energy. *(buy more recycled and recyclable products, etc.)*

Extension Activities

1. Have students research the resources, energy and waste involved in producing other recyclable materials such as aluminum and plastic.

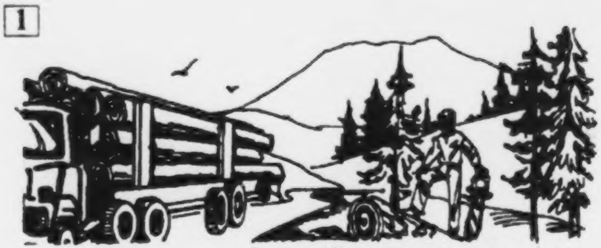
2. Have students create a world resource map, showing where resources are located. Include:

- ores for steel
- bauxite for aluminum
- sand, lime, and soda ash for glass.

Have students choose a resource and research the process by which it is mined and brought to factories.

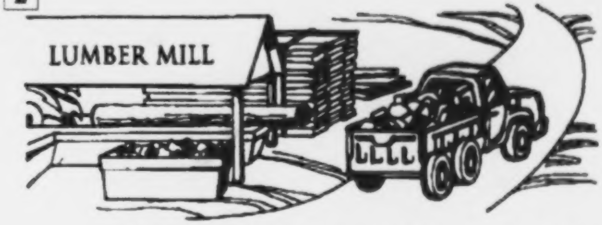
Paper Manufacturing

1



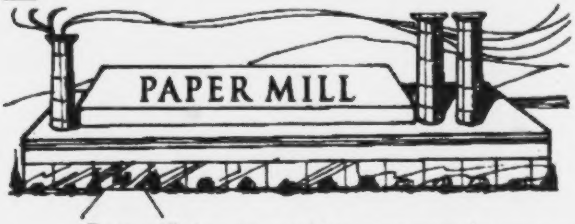
It takes 17 trees to make one ton of paper.

2



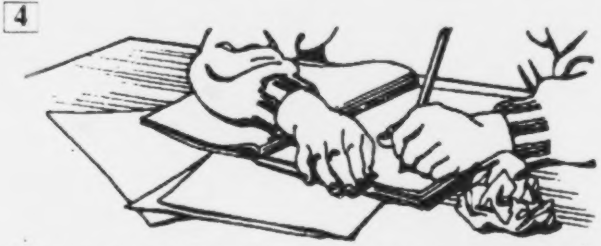
Wood wastes from lumber mills are used to make paper.

3



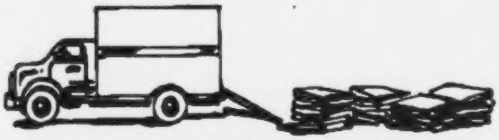
Paper mills turn the wood into paper ready for you to use.

4

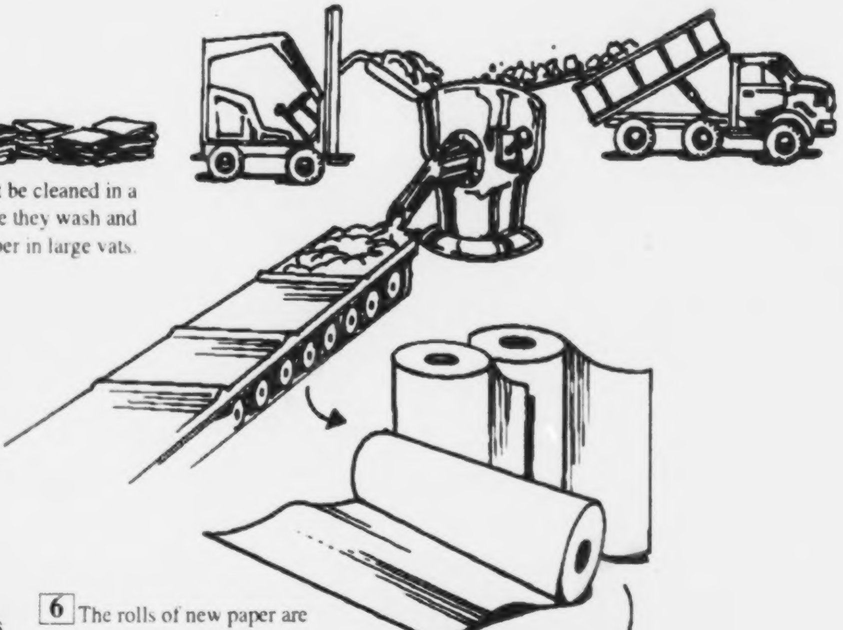


Once paper is used, it should be sent to be recycled, not thrown away.

5

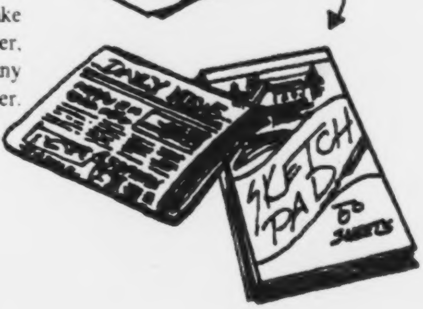


Old paper, like newsprint, must be cleaned in a processing called "de-inking" where they wash and rinse the paper in large vats.



Sometimes newsprint and wood wastes are combined, mixed into a pulp and poured onto large rollers. Other times mostly used paper is processed again.

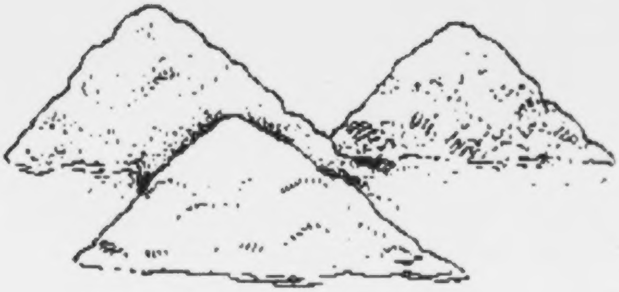
6 The rolls of new paper are used again to make newspapers, drawing paper, computer paper, and many other kinds of paper.



3,688 pounds (1,673 kg) of wood, 216 pounds (98kg) of lime, 360 pounds (163 kg) of salt cake, 76 pounds (34 kg) of soda ash, 24,000 gallons (90,840 kl) of water and 28 million Btus of energy are required to make one ton of paper.

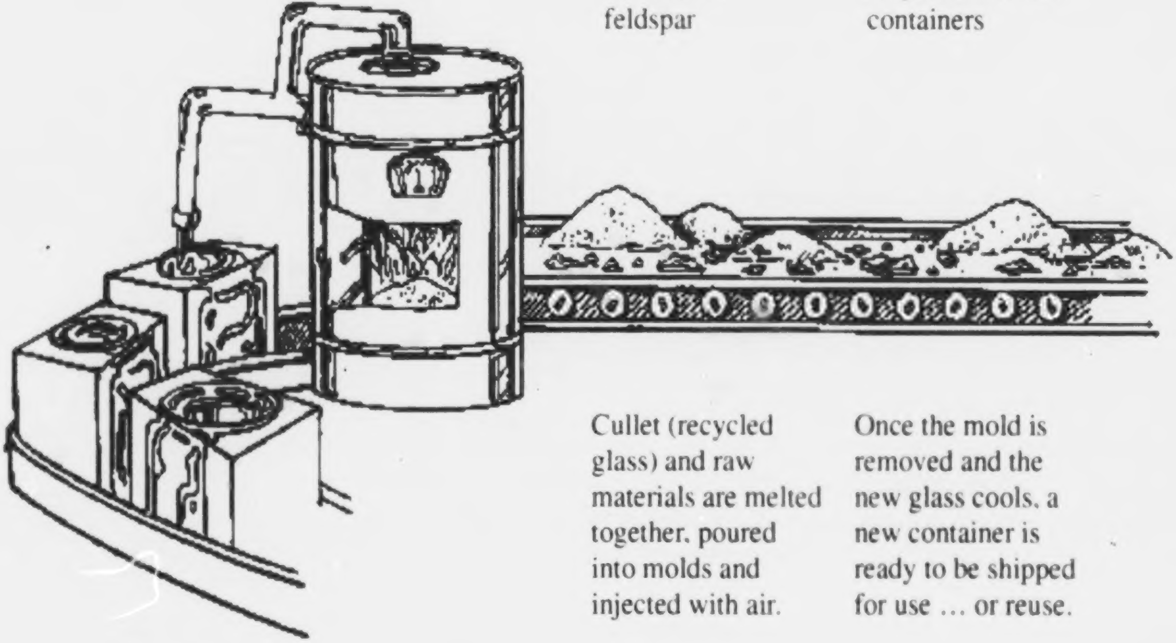
In addition, 84 pounds (38 kg) of air pollutants, 36 pounds (16 kg) of water pollutants and 176 pounds (80kg) of solid waste are created.

Glass Manufacturing



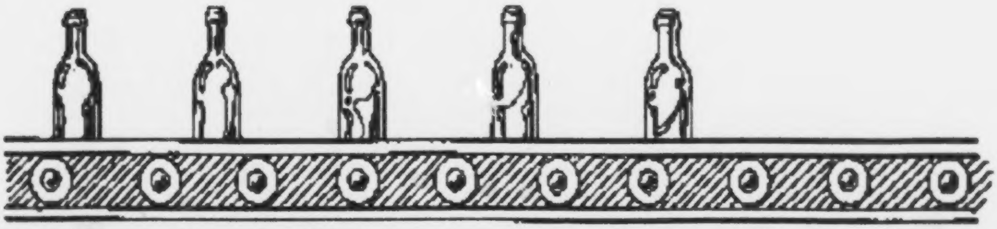
Raw Materials:
sand, soda ash,
limestone,
feldspar

Recycled Materials:
cullet or glass to be recycled into new containers



Cullet (recycled glass) and raw materials are melted together, poured into molds and injected with air.

Once the mold is removed and the new glass cools, a new container is ready to be shipped for use … or reuse.



1,330 pounds (603 kg) of sand, 433 pounds (196 kg) of soda ash, 433 pounds (196 kg) of limestone, 151 pounds (68 kg) of feldspar and 15.2 million Btus of energy are required to make just one ton of glass. Major deposits of white sand suitable for making glass are found in Illinois, New Jersey, the Alleghenies and the Mississippi Valley. Most soda ash comes from Wyoming and 65 percent of the feldspar in the United States comes from California and North Carolina.

Different colored glass is produced by adding small amounts of other substances such as iron, copper and cobalt. Green glass is made by adding iron.

Trash Flash Through Time

Preparation Time: **Easy-To-Do** Moderate Extensive

Grade: 4 – 5
Focus: Reducing trash
Subject: Social Studies, Language Arts
Materials: *Trash Flash* survey sheets included
Teaching Time: 30 minute introduction and survey assignment
Vocabulary: Recycle, reuse

Learning Objective

Students will:

- see how solid waste has been dealt with in the past and why there is a solid waste problem in modern times
- examine recycling of the past and compare this to recycling today.

Learning Procedure

1. Students will listen carefully and follow along as the teacher takes them on a journey through time. Read the story, *Trash Flash Through Time*, to the class.

2. Immediately following the story, ask the class to consider these questions:

a) What was the garbage that was tossed out the window and onto the streets of London 700 years ago? *(Were there cans, glass, paper, aluminum, plastic containers, food waste?)*

b) Describe the method of disposing of garbage 700 years ago.

c) What is the composition of modern day garbage? *(Food and yard waste, paper, aluminum, tin, glass, cardboard, plastic)*

d) What is our method of disposing of garbage? *(Primarily landfilling and incineration)*

e) What do you think was the first attempt to **recycle**? Did your grandparents recycle? How can we find out?

3. Tell the class that perhaps we can learn something about recycling from our past. Our grandparents and their parents recycled or **reused** many materials that are commonly thrown away today. Have students interview a grandparent or other older person in their family or neighborhood using the *Trash Flash Through Time* survey included with this lesson. Students may need to practice their interview skills before beginning this exercise.

Questions for the Class

After students have completed their interviews, have them participate in this discussion.

1. What items did your grandparent or friend recycle?

2. How did they conserve resources?

3. What materials were used for packaging then?

4. How did they keep food items from spoiling?

5. Make an "I learned ..." statement regarding your grandparent's use of resources.

6. Have students include their statement in "Thank You" notes to the persons interviewed.

DOWN TO EARTH

Citizens of the United States and Canada generate twice as much garbage per person as individuals in other industrialized countries.

Let's Take A

Trash Flash Through Time

You are walking through a quiet, beautiful forest. You feel happy to be in such a peaceful, lovely place as this. You come to an opening under a canopy of leaves, and in the rays of sunshine you see a strange and unexpected sight. It looks sort of like a car, sort of like a thing one would ride at a carnival. It looks like a whole lot of fun, whatever it is, so you open the door and step inside a most miraculous little machine.

There are lights, buttons, levers, graphs, clocks, dials, calendars, and computer screens ... and you know at once — This is a time machine!

Carefully following the instructions on the screen, you fasten your safety belt, set the clock in reverse, and wait. Dials spin, buzzers sound, and you feel yourself being thrust back into your seat. On the big computer screen above your head, you see events in time come to life; the first trip to the moon; World War II planes flying over Europe; George Washington crossing the Delaware during a harsh winter storm; the Nina, Pinta and Santa Maria ships heading westward. Wait! It's going too fast! You've got to stop this thing! Your finger finally finds a button marked STOP. You press it and the year 1250 flashes above. The machine stops! And the door opens slowly behind you...

It is a misty morning on a cobbled stone street, fog is rolling in and there is a chill in the air. Signs hanging above the shops let you know you're in London, England. The clopping hooves of a horse-drawn cart can be heard in the distance. Squealing piglets are being joyfully chased by children running all about. Then from above, SPLASH! PLOP! Out of an open window two stories up comes a shout, "GARDY-LOO!" followed by a heaving bucket of garbage. Vegetable peels and table scraps fall right onto the street below. It barely misses you! And now here come the pigs, rushing to the scene to investigate the tasty morsels of garbage they might eat.

Can you imagine, people throw garbage out of their windows and onto the streets. Pigs run freely about to eat whatever is edible.

"GARDY-LOO!" The call comes again. Oh! No! Look out. Running, ducking and jumping over slippery, slimy garbage, you head back to the time machine, set the dials to the present, and hit the buttons again. You feel yourself being flung forward in your seat. Dates fly past on the dial, and before you know it, you're back, right where you were when you found the machine.

WHEW! What a trip! The door opens behind you, but you remain seated as your mind continues to spin with the memory of your adventure.

Just think of all the garbage! It's good to be back home.

Extension Activities

1. Invite two or three senior citizens to share stories about what life was like when they were students in school. Have them talk about garbage, things they threw away and things they reused and repaired.

2. Have the students fill out a survey today as if they were adults talking to 4th and 5th graders in the future. Students would describe themselves and their lifestyle habits as they are today. Try to have copies of all the surveys from this lesson included in the school archives or time capsule.

3. Complete the questionnaire, *Trash Flash to Today*. Answers are included in italics.

4. Have the class visit a nursing home to talk with the residents about how the world has changed during their lifetimes.

Just Do It

Try life in the Good Ol' Days.
Try to live one day as your grandparents might have.
Remember, no television, no microwave
and no convenience products.

Trash Flash to Today!

Can you answer these questions?

1. How much trash does each person in the U.S. throw away daily? *(5.6 pounds (2.52 kg) can be attributed to each individual, 8.5pounds (3.83 kg) per person per day includes all wastes such as manufacturing wastes combined with household wastes.)*

2. What material is thrown out more than any other? *(Paper makes up 40 percent, 37.6 percent.)*

3. Is most of our garbage **a)** buried in landfills, **b)** burned, **c)** reused, or **d)** recycled? *(In South Carolina about 80 percent of garbage is landfilled. In some areas of the Low Country, garbage is incinerated at a waste-to-energy facility.)*

4. Are dumps and sanitary landfills the same? *(No, sanitary landfills have liners to protect the soil and groundwater nearby, dumps are illegal.)*

5. How many aluminum cans are thrown away each year rather than recycled? *(34.8 billion. And imagine that each can is half filled with gasoline, because that's how much energy is lost! More than 60 percent of aluminum beverage cans are recycled.)*

6. How much of our trash is packaging? *(32 percent by weight and 30 percent by volume.)*

7. To recycle means to process waste materials into new products ... true or false? *(True. For example, recycling newspaper into cardboard boxes, or melting down used glass jars to make new ones.)*

8. If you could change something about the way you recycle, what would it be?

220

Trash Flash Through Time

Older & Wiser Survey

Begin by explaining: We are conducting interviews with the older generations so we can learn how people handled their garbage and resources in the past. Your stories are valuable to our research. Thank you for agreeing to do this interview.

Please answer all of the questions for the time period when you were my age.

1. What is your full name?____

2. Where were you born? ____

3. What was the year when you were my age? ______________________________

4. What did you do for fun? ____

5. How old were you when you got your first TV? ____________________________

6. What chores did you do? ____

7. How did you get to school? ______________________________________

8. What toys did you have? ____

9. What were they made of? _______________________________________

Food

10. How was your family's food kept fresh? ______________________________

11. How did store-bought food come packaged? ___________________________

12. What did you do with the package or container when it was empty? ________________

____

13. Did you carry your own lunch? ________ In what containers? __________________

14. If you ever brought food home from a restaurant, how was it packaged? (Was paper or plastic used?)

____

Paper

15. What did you do with old papers, magazines & books? ________________________

Older & Wiser Survey

16. Did you use paper napkins, tissues or towels? ____________ if not, what did you use? ____________

17. Did stores provide paper shopping bags? ____________

Glass

18. What types of glass containers did you have? (jars, soda bottles, milk bottles, etc.) ____________

19. Did you throw them away, reuse or recycle them? ____________

Aluminum

20. Did you have aluminum? ____________ For what uses? ____________

21. Did you throw it away? ____________

Tin Cans

22. What kinds of food did you buy in cans? ____________

23. What did you do with the cans when they were empty? ____________

Plastic

24. Were there plastic containers? ____________ What came in them? ____________

25. What was in your first plastic bottle? ____________

Garbage

26. Where was your garbage thrown? ____________

27. Was any of it recycled or reused? ____________

Wrap-up Questions

28. Did people talk about recycling and conserving resources then? ____________

29. How do you think people today have changed in their attitudes? ____________

30. Would you rather be a child in today's times or the times when you were a child? ____________

Thank You!

Action for a cleaner tomorrow.

A South Carolina Environmental Curriculum

For more information about South Carolina and the environment, call the
South Carolina Department of Health and Environmental Control at
1-800-768-7348.

Trash or Treasure

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 4-5
Focus: Reuse
Subject: Social Studies, Language Arts
Materials: Reuse objects, the poem, *Hector the Collector* by Shel Silverstein, worn clothing or patchwork pieces (have students bring to class), pictures of quilts
Teaching Time: One to two class periods
Vocabulary: Reuse, recycle, compost, waste stream

Learning Objective

Students will:

- create ways to reduce solid waste by reusing some things that might be thrown away.

Background

Studies at selected landfills indicate that almost 60 percent of what we throw away still has a value and could be **reused**, **recycled**, or **composted.** South Carolina's waste reduction goal is outlined in the Solid Waste Policy and Management Act. According to the Act, 25 percent of what currently enters our **waste stream** should be recycled, and our total waste volume should be reduced by 30 percent by weight.

Diverting resources from the **waste stream** begins with recognizing the resource potential of what we throw away each day.

Learning Procedure

1. Read the poem, *Hector the Collector* by Shel Silverstein. Show the class two examples of reuse objects: an object you are reusing for its original purpose *(such as a canvas lunch sack)* and one for which you have created a new use *(such as a bottle or jar that is reused as a flower vase).*

2. Show the worn clothing items and patchwork pieces that you and the students brought to class.

3. Share pictures of quilts. **Ask:** Where do you think the individual patches may have come from *(such as red calico could have been a shirt; denim from a pair of jeans).* **Ask:** Why did people in the past make patchwork? In what ways has patchwork become part of our history? *(Different patterns represent different time periods or styles.)* In what other ways have people *reused* items that otherwise would have been thrown out?

4. Brainstorm ways to reuse the clothing and fabric scraps students brought to class. **Suggestions:** make puppets, quilts, pot holders, braided rugs, books, collages, fabric flowers, purses, pillows or book marks.

Other ideas for reusing fabric:
Book covers: fabric scraps can be used for book covers by wrapping and gluing fabric in place.
Coupon Keepers: Fold fabric scrap in half. Have students sew up sides with yarn, creating a pouch.
Decorate boxes with fabric scrap designs. Use the boxes to collect recyclable materials. Keep a decorated box in the classroom for paper collection.

Extension Activities

1. Have students think and write about other things besides fabric they have thrown away that could have been used again or made into something new.
2. Invite a quilt maker to visit and demonstrate.
3. Have students investigate different quilt patterns made by different groups in American history.

DOWN TO EARTH

Japan imports for recycling about 126 metric tons of the United States' used beverage cans in a single month.

Source: Institute of Scrap Recycling Industries

Hector the Collector

by Shel Silverstein

Hector the Collector
Collected bits of string,
Collected dolls with broken heads
And rusty bells that would not ring.
Pieces out of puzzles,
Bent-up nails and ice-cream sticks,
Twists of wires, worn-out tires,
Paper bags and broken bricks.
Old chipped vases, half shoelaces,
Gatlin' guns that wouldn't shoot,
Leaky boats that wouldn't float
And stopped-up horns that wouldn't toot.
Butter knives that had no handles,
Copper keys that fit no locks,
Rings that were too small for fingers,
Dried up leaves and patched-up socks.
Worn-out belts that had no tracks,
Airplane models, broken bottles,
Three-legged chairs and cups with cracks.
Hector the Collector
Loved these things with all his soul–
Loved them more than shining diamonds,
Loved them more then glistenin' gold.
Hector called to all the people,
"Come and share my treasure trunk!"
And all the silly sightless people
Came and looked … and called it junk.

The Story of....(Packaging)

Preparation Time: **Easy-To-Do** Moderate Extensive

Grade: 4 - 5
Focus: Reduce packaging
Subject: Social Studies, Language Arts
Materials: Aluminum can, plastic bag, cardboard box, steel can, glass bottle, *One Family Meal* and *Profile of a Package* included
Teaching Time: Several class periods.
Vocabulary: Packaging, source reduction, reuse, recycle

Learning Objective

Students will:

- gain a better understanding of the resources that make up some typical packages and potential ways to reuse or recycle them
- identify many kinds of packaging
- describe waste disposal problems caused by packaging
- identify solutions for managing our packaging waste problems.

Background

In the past, packages were refillable and reusable, such as thick glass bottles and cotton flour sacks. Today, our society manufactures approximately 660 pounds (299 kg) of packaging per person each year, and almost 90 percent of it becomes solid waste!

Packaging is necessary, but most companies design packages to be appealing and to sell the product, not to protect the environment. Packaging is defined as "excessive" when the wrap for the merchandise is not necessary for the sale of the product. A good example of excessive packaging is bananas packaged in plastic wrap and a plastic tray. Other examples are convenient, single-serve snack items such as crackers, meat, cheese and a napkin packaged into one "meal."

Packaging accounts for nearly one-half of the waste disposed of in landfills and incinerators. And much of packaging is plastic. Although plastic is designed to last many years, a third of the plastics produced in the United States is used in products with a lifespan of less than one year.

Reducing how much packaging we buy – **source reduction** – could greatly extend the capacity of our waste disposal systems, and at the same time, will conserve our natural resources and reduce pollution during the manufacturing and disposal stages of packaging.

Learning Procedure

1. Divide the class into five groups, each group representing one of the following common types of packaging:
   - aluminum can
   - plastic bag
   - cardboard box
   - tin can
   - glass bottle.

2. Each group will research a packaging type. You may want to provide the attached guessing game questions *Profile of a Package* as a guideline.

3. After completing the research, each group will report to the rest of the class what they have discovered about their type of packaging.

DOWN TO EARTH

An Australian company has developed a building insulation product using recycled polystyrene. McDonald's Corporation built a restaurant in Arizona with 10 percent cement and 90 percent recycled polystyrene.

Source: *Recycling Today* magazine, August 1991

4. As a class, compare reports, discuss advantages and disadvantages of each type of container and decide which is most desirable.

5. Show examples of mixed packaging and discuss the problems caused by mixed packaging. *(Difficult to recycle.)*

6. Have students collect samples of packaging from products they buy for a period of time. Could they have made wiser choices in their product selection? Could the manufacturer have made wiser choices in the packaging?

Extension Activities

1. Ask students to compare how packaging is used today with how items were packaged in the past. *(For example, today we buy many types of processed and prepared frozen potato items. In the past, vegetables may have been grown by the family and served fresh from the garden, or potatoes were purchased in sacks that were reused or returned to the store.)*

2. Have students take home and complete the handout *One Family Meal*, and discuss the results with the class.

3. Have students select one package type and design an environmentally sound package for the product taking into consideration product safety, shipping, and advertising/merchandising. This package would use few resources and also leave behind only a small amount of solid waste.

Just Do It

Reject items that are more packaging than product. If a product you want to buy is not available in reasonable packaging, or packaging that can be reused or recycled, write the manufacturer!

Profile of a Package

I am a ____________________ container.

1. Describe me.

2. What are some of the things I am used for?

3. What am I made of?

4. What natural resource do I come from?

5. Are large amounts of my raw materials available?

6. How does if affect the earth when people extract my raw materials?

7. Does it take a large amount of energy to produce me?

8. Am I thrown away after I am used?

9. Am I biodegradable? Am I photodegradable? (That is, will I breakdown in sunlight?)

10. Do I disintegrate if I am thrown into a river, lake or ocean?

11. What are some ways in which I could be reused?

12. Can I be recycled? Am I recycled? Where am I recycled?

13. What happens to me when I am recycled?

14. Who is responsible for disposing of me?

15. Who pays the cost for disposal?

16. Do you think I am a good container? Why or why not?

17. What would you do to improve me?

One Family Meal

Name ________________

Parents: Your child is studying the affect that product packaging has on what we throw away. For this exercise, we ask that you let you child assist your in preparing a meal in order to list all the packaging required in the components of a single meal. This meal may be simple soup and sandwiches, no special menu or preparation is required. Thank you.

Student: You are the cook's assistant for tonight's family meal. List all the packages and containers you will open to prepare the menu. (For example boxes with liners, cans, jars, bottles, bags, etc. You do not have to open the container for the first time to list it, and you do not have to use all of its contents. For example, if you use a spoonful of mayonnaise from a jar in the refrigerator, you would list the glass mayonnaise jar and the metal lid.

Food Item Name	Package or Container Description
Mayonnaise	*Glass jar with metal lid, 6 oz. (177 ml)*
Jello	*Box with paper liner, 4 oz. (118 ml)*

Action for a cleaner tomorrow.

A South Carolina Environmental Curriculum

For more information about South Carolina and the environment, call the South Carolina Department of Health and Environmental Control at 1-800-768-7348.

Solving the Can-Can Mystery

Preparation Time: Easy-To-Do Moderate **Extensive**

Grade: 4 – 5
Focus: Recycling cans
Subject: Social Studies, Science, Language Arts
Materials: See list of materials itemized below
Teaching Time: One to two class periods
Vocabulary: Aluminum, tinned metal, bimetal

Learning Objective

Students will:

- use magnets, pan balances and observation to differentiate between aluminum, tinned and bimetal cans
- record their data
- list four ways recycling metal cans is good for the environment.

Materials

For each group of 4 to 5 students: small magnets, samples of aluminum, tinned and bimetal cans, (include both aluminum soda cans and bimetal food cans), pan balance, *Solving the Can-Can Mystery* worksheet (one per student). Note: this can also be performed as a demonstration activity if materials are limited.

Background

There are three general categories of metal cans: **aluminum**, **tinned** and **bimetal**. Bimetal does not refer to a can that has two metals combined to form an alloy, but to a can with steel lids enclosing an aluminum body. Tinned cans are actually 99 percent steel with a thin coating of tin. At first glance, bimetal and aluminum cans are very similar in appearance, but it is important to distinguish between them because bimetal cans are not easily recycled. It is also important to identify different types of metal cans because they need to be separated before recycling.

Perhaps the easiest way to identify the different types of cans is with a magnet. Magnets will not attract aluminum, but will attract other kinds of metals containing iron, such as steel. Other differences include appearance, weight, color and response to chemicals.

Energy saved by making aluminum cans from recycled aluminum is 90-95 percent; energy saved by recycling steel is 60-70 percent. Not only are natural resources conserved by recycling, but recycling also takes these materials out of the waste stream, reducing the amount of trash put into our landfills. For more information on metals, see the Resource section.

Learning Procedure

1. Begin a discussion of waste management by discussing how recycling:
   - reduces the waste stream
   - conserves energy
   - reuses natural resources because new cans are made from the used ones
   - reduces pollution from mining and production operations.

2. Define recyclable cans as those easily made into new cans. Metal cans are recyclable, but some types of metal cans are much easier to recycle than others. Hold up samples of the three basic types of cans: aluminum (soda cans), tinned/steel (soup cans) and bimetal (some tuna fish cans, small juice cans,

DOWN TO EARTH

Most of the world's bauxite ore, the raw material for which aluminum is made, is located in the subtropics. The United States imports 90 percent of its bauxite.

tennis ball cans and many soda cans). Pay extra attention to the bimetal and aluminum cans which look alike, but are made differently. Explain that a bimetal can has an aluminum body and steel lids and that these cans are difficult to recycle because the two metals must be separated before recycling.

3. Explain and demonstrate to students the following ways to tell the differences between metals:

Magnetism: Hold up a magnet. Ask for a show of hands of students who have experimented with magnets. Did they notice the things that magnets will attract? Explain that magnets are pieces of iron or steel or other materials that can attract some kinds of metals. (This property may be naturally present or artificially induced.) Experiment with objects to show how some are attracted to the magnet and others are not. Demonstrate that magnets attract tinned/steel and bimetal cans (the lids), but not all-aluminum cans. Explain that recycling centers use large magnets to separate the all-aluminum cans from other metal cans.

Appearance: Hold up can samples. Explain that aluminum cans look almost identical to bimetal cans, but can be identified by color, weight, recycling symbols, rims around lids, etc. Point out the differences in the tinned/steel cans (ribbing, weight, rims, etc.) Refer to the Teacher Information.

Weight: Using a pan balance, weigh the two soda cans, one aluminum and one bimetal, but do not tell students which can weighs more. Ask them which can they think is heavier.

4. Divide the class into groups of 4 or 5 students and distribute the worksheets. Set up stations in the room so that groups can practice separating cans by: (a) using magnets: (b) observing differences in appearance and (c) weighing.

5. Have students list four ways recycling metal cans is good for the environment.

Extension Activities

1. Have students illustrate or write a procedure for sorting cans for recycling.
2. Visit the local recycling center to observe how cans are sorted commercially before recycling.

Teacher Information

Aluminum	Bimetal	Tinned/Steel
Not attracted by a magnet	Body is attracted by a magnet, but lids of can aren't	Attracted by a magnet
Bottom does not have a rim and has a finely brushed, polished appearance	Bottom has a rim and is not finely brushed	Bottom has a rim
Body is shiny, silver and smooth with no seams	May or may not have seam	Body has rings or ribbing, always has a seam
Label is usually spray-painted onto can and most say "All Aluminum Can" on the side	Usually spray-painted	Normally has a paper label
Lightest weight	Heavier weight	Heaviest weight

Name________________________________

Solving the Can-Can Mystery

Use "Yes" or "No" to complete the table.

	ALUMINUM CAN	BIMETAL CAN	TINNED CAN (actually 99 percent steel)
MAGNETIC			
SEAMS			
BOTTOM RIMS			
SMOOTH, RIBBED			
FINELY BRUSHED OR POLISHED			
LABEL (painted or paper)			
RECYCLING SYMBOL			
TYPE OF PRODUCT			
MASS (GRAMS)			

Which type of can is heaviest?______________________

Which type of can is lightest?______________________

Which type of can is easiest to recycle?______________________

List four reasons recycling metal cans is good for the environment.

1.____

2.____

3.____

4.____

Action
for a
cleaner tomorrow.

A South Carolina Environmental Curriculum

For more information about South Carolina and the environment, call the South Carolina Department of Health and Environmental Control at 1-800-768-7348.

Plastics By The Numbers

Preparation Time: Easy-To-Do **Moderate** Extensive

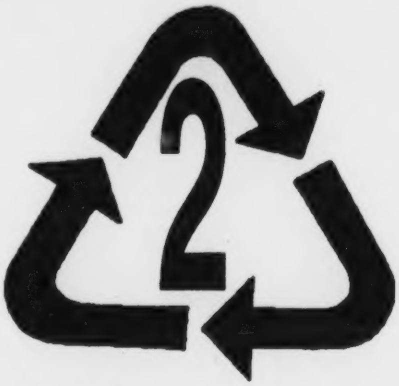
Grade: 4 - 5
Focus: Plastics recycling
Subject: Social Studies, Science
Materials: Collection of plastic samples, *If You Know the Code* and *Plastic Code Analysis* handouts
Teaching Time: Two partial class periods
Vocabulary: Code, recycle, resin

Learning Objective
Students will:

- recognize the role of plastic in our society
- understand the plastics coding system
- understand why plastic must be separated for recycling.

This activity uses the voluntary *Plastic Container Coding System* established by The Society of the Plastics Industry. The **codes** benefit manufacturers and recyclers, but they have application in the classroom and the home. You will find these codes on the bottom of many plastic items. Once you learn the codes, you'll find yourself examining the bottom of all kinds of plastic containers!

These plastic coding symbols — although they currently include the recycling-chasing-arrows design — do not mean that the item is recyclable. Please find out which plastics are recyclable in your area before beginning this lesson. In South Carolina, the Solid Waste Policy and Management Act requires this numbering system to be on all plastics.



Learning Procedure
It may be beneficial to present this lesson in two parts, one to introduce plastics, assign students to look for plastics and bring in samples; and a second session on examining the types of plastics and recycling.

Part One

1. Introduce the topic of plastics. Brainstorm uses of plastic from milk jugs to auto parts to home siding. *(Refer to information in the Resource section on Plastics and the information included in this lesson entitled:* Understanding Plastics.*)*

2. Provide students with copies of the handout *If You Know The Code* and discuss it. Practice pronouncing the full name of each type of plastic.

3. Assign students to bring in samples of the various types of plastic for the next session.

Part Two

4. Distribute copies of the *Plastics Code Analysis* handout. Have students sit in a circle around the pile of plastic containers they have brought. Have each student choose a plastic item from the pile and record the required information on their sheet.

5. On the teacher's signal, students start the waste

DOWN TO EARTH

In December 1987, the United States became the 29th nation to ratify a treaty prohibiting boats and ships from dumping plastics anywhere in the oceans.

stream "flowing" by passing their item to the student on their right and filling in their *Plastic Code Analysis* sheet. Keep the stream flowing until all blanks on the handout are filled or until all seven types are entered. Students may draw in new samples from the pile as needed to keep the activity moving. Have students discuss their findings. After the activity, have students group the items by number and discuss.

6. What types of plastic are **recycled** in your community? Share this information with the class.

Extension Activity
Have students complete the *Take Home Science: Plastic Code Survey* included in this lesson.

Understanding Plastics

The simple word *plastic* is a collective reference to a wide range of materials. This can cause confusion. It's no wonder; there are about 45 basic families of plastics and each can be made with hundreds of variations. Today most plastic containers are made from six primary resins. These resins are represented by the plastic container coding system.

Plastics are made from materials found in nature – petroleum, natural gas, and coal. Basic compounds of carbon, hydrogen, oxygen, and nitrogen are extracted and combined to produce many kinds of plastic **resin.**

Plastics come in three basic forms. One form is *thermoset* plastics, which can be heated and molded only once. These plastics are not degradable. Automobile bodies and bakelite used in nonstick cookware are examples of thermoset plastics.

The second type of plastics, *thermoplastics* (plastic milk jugs, etc.), are recyclable and not degradable. They may be remolded several times. Some reuses for thermoplastics are boat docks, pallets, and filler for insulation in ski jackets.

The newest type of plastics are *degradables*. Some degradables can be broken down by light, others by salt, and still others by biodegradation. Degradable plastics are not recyclable.

The popularity and wide use of plastic can be attributed to its wide range of properties and design possibilities.

At Home, plastic:
- protects products
- resists breakage
- makes handling easier
- allows tamper protection
- adds convenience
- allows use of lightweight windows, pipes, flooring.

At Work, plastic is found in:
- furniture and upholstery
- classroom erasable boards
- assembly line parts that don't corrode
- lightweight automotive parts
- fax machines
- computers
- copiers.

At Play, plastic is used to make:
- toys
- movies
- safety helmets, mouth guards
- boats
- dome stadiums
- campers
- playground equipment.

In Health Care, plastic is used for:
- artificial hearts
- artificial limbs
- contact lenses
- x-ray film
- filtering devices
- tubing
- special disposable items that help guard against infection, contamination.

Did you know?

- Pound for pound, plastic products account for only about 9.3 percent of municipal solid waste. Yard and food waste, by comparison, account for about 22.6 percent of the solid waste stream. Paper and paperboard account for about 37.6 percent.

- Plastic beverage containers have the second highest "scrap value" of recyclable materials in packaging – next to aluminum.

- Plastic products have the highest energy value for modern waste-to-energy incineration. For example, the energy content of a pound (454 g) of polyethylene is 19,900 Btu. A pound (454 g) of Wyoming coal has an energy value of 9,600 Btu.

- Plastic products have already contributed substantially to source reduction in the waste stream by replacing heavier, thicker materials previously used in packaging. This is accomplished by engineered reductions in the amount of plastic used in containers such as the soft drink bottle.

- Only five recycled soda bottles makes enough fiberfill for one ski jacket.

- Americans discard at least $120 million worth of recyclable milk jugs, butter tubs and other #2 HDPE plastics each year.

- Every year we make enough plastic film to shrink-wrap Texas.

ROOT BEER
SOF-D
UP SODA
Cola

IF YOU KNOW THE CODE ... You can tell what resin the product is made from.

To make recycling easier, plastics manufacturers are now using a **standard coding system** on single use plastic containers to identify the **resin** type (the artificial substance similar to natural resin from trees.) Since plastic recycling opportunities are different throughout the country, consumers should find out which types of plastics are recycled in their communities and make purchases and recycle accordingly. The plastic type used for many typical products is changing as more manufacturers move to packaging using Number 1, PET and Number 2 HDPE. These two plastic types are the most recycled in South Carolina.

Plastic Container Code System For Plastic Containers

Symbol/Code	Material	Typical Products	Can Be Recycled Into
♳ PET or PETE	Polyethylene terephthalate (PET or PETE)	soft drink bottles, peanut butter jars, many food packages, shampoo bottles	carpets, surfboards, sailboat hulls, strapping
♴ HDPE	High-density polyethylene	milk, water & juice jugs, detergent bottles	trash cans, base caps for soda bottles, detergent bottles, drain pipes
♵ V	Vinyl/polyvinyl chloride (PVC)	some shampoo bottles	fencing, handrails, house siding
♶ LDPE	Low-density polyethylene	dry cleaning bags, bread & trash bags, some squeeze bottles	grocery bags, garbage can liners
♷ PP	Polypropylene	some yogurt cups	birdfeeders, pails, water-meter boxes, car-battery cases
♸ PS	Polystyrene	egg cartons, meat trays, coffee cups, carryout containers, video tapes	pencil holders, tape dispensers, license-plate frames, trays
♹ Other	All other resins and layered multi-material	microwavable serving ware	benches, picnic tables, roadside posts, marine pilings

Plastic Code Analysis

Number Symbol	Letter Code	Product Name	Package Properties
♳ ♴ ♵ ♶ ♷ ♸ ♹	*PET or PETE* *HDPE* *V or PVC* *LDPE* *PP* *PS* *other*	*In this column write the name of the product*	*Describe the package using terms such as: flexible, rigid, transparent, opaque, translucent, color, white creases form when crushed*

Name ______________________ **Date**______________________

Take Home Science: Plastics Code Survey

Directions: Select a location for your survey, either at home or a grocery store. Look for items made of plastic. Examine the bottom of each item. Find the arrow plastic code symbol. Record the number symbol and the letter code for each plastic item.

Example:

1 PET	3 PVC

Where did you do your survey? At Home _____ At a store ________
Which rooms at home?____.
Which aisles at the store? ____.

DATA COLLECTED

Analyze your data. Count how many times you found each code. Which was the most frequent? Which was the least?

Waste Management & the Law

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 4 – 5

Focus: Waste management history and law

Subject: Social Studies, Language Arts

Materials: Solid waste management in SC information; list of local, state, and national government officials

Teaching Time: One to two class periods

Vocabulary: Legislation, regulations, Department of Health and Environmental Control, U.S. Environmental Protection Agency

Learning Objective

Students will:

- examine the need for strict waste management laws
- review South Carolina's waste management laws and goals.

Learning Procedure

1. **Ask:** What would happen if there were no laws to protect the environment? Do you think our laws are strict enough? Do you think our laws are too strict?

2. Divide the class into six teams. Have the teams investigate and illustrate a time line of waste management and the law. Use the waste management information included with this lesson as a guide for the students' time line research.

3. After completing the time lines, have students brainstorm local community needs in the area of environmental protection *(for example, the need for recycling centers and local composting facilities.)*

4. Have students write letters to government officials expressing their concerns about solid waste management. Letters can be sent to representatives on local, state, and national levels.

5. Contact your local office of the State Department of Health and Environmental Control and invite a representative to your class to discuss laws, regulations, and their enforcement. For more information or help in locating your local DHEC office call 1-800-76-USE-IT.

Extension Activity

Have the class brainstorm environmental careers. Let each student select a career, research the educational requirements and job duties, and share information in the form of a resume presentation.

Professions include: biologists, chemists, recyclers, ecologists, and engineers.

DOWN TO EARTH

In 1992 the United Nations' Conference – the Earth Summit – held in Rio de Janeiro, Brazil, focused world attention on the environment.

Time line Guidelines

The Past

Trash disposal is an ancient problem that has typically been dealt with in the cheapest, quickest way. In ancient Rome, trash was taken outside the city walls and burned. In the 1200s in cities such as London, garbage was heaved into the streets from the window. Pigs roamed the streets eating garbage. If you heard the phrase "Gardy-Loo" watch out. Garbage coming down.

In the 1700s, communities relied on open burning and dumping as methods for solid waste disposal. Trash was disposed of in unpopulated areas considered unfit for development, such as river banks, wetlands, floodplains, marshes, swamps, and bogs.

By the mid-1800s unsightly dumps were causing a number of health problems such as attracting rodents and other pests which transmit infectious diseases. As populations grew, so did refuse accumulation, and the question of what to do with household garbage went unanswered. By the late 1800s, some communities passed ordinances to clean up refuse areas, but there were no laws regulating manufacturing wastes.

At the Turn of the Century

At the turn of the century, most communities in the United States dumped their waste in marshes and wetlands. These areas were considered unsuitable for development and could be purchased at very low prices by local haulers and municipal governments. The prevailing belief was that the soil would act as a natural filter, and that as the waste seeped through the ground, it would be cleaned. No one anticipated the consequences of ground water contamination and the effects on public and private water supplies. Garbage dumps were frequently located in areas where supplies of fresh ground water were replenished by rainfall, the same places where many towns were also locating drinking water pumps and wells.

In the 1930s much waste was burned in open pits to reduce its volume before burial. Open pit burning caused its own problems, and there were frequent landfill fires. First, surrounding neighborhoods lived with continuously smokey air. Second, the fire department always seemed en route to put out landfill fires. In fact, landfill fires were so abundant that they were used by fire departments to train newly-enrolled firefighters.

Communities responded to these problems by passing ordinances limiting open burning to specific areas. As the need for disposal grew, the availability of marginal land for disposal decreased and many cities built incinerators, further reducing the need for land to bury garbage.

With household garbage piling up, industrial wastes were also accumulating as the demand for new "convenience" consumer goods grew. From 1900 to 1948, although the industrial revolution was in full swing, no significant environmental legislation was passed. By the time people learned that waste management of harmful industrial by-products was needed, millions of tons of chemicals and other wastes had already been released into our air, water, and onto our land.

1948 Federal Legislation

In 1948 the original federal Water Pollution Control Act was passed. It said that waste disposal was a fundamental use of water. Public awareness of the importance of water and land-use preservation grew dramatically during the 60s and 70s. Attention focused on wetlands, floodplains, and other water resources which were the very areas where garbage and industrial waste were being dumped and buried.

Most communities disposed of the waste in landfills.

Lobbying efforts on the part of environmental groups such as the National Audubon Society and the Sierra Club led to legislative action, including passage of the National Solid Wastes Act in October 1965. This Act required all states to accept federal guidelines structuring regulations for solid waste management and disposal. Each state could add to these requirements as it saw fit.

On the federal level, policies are created by the United States **Environmental Protection Agency**. U.S. EPA, formed in 1970. The U.S. EPA's mission is to administer and enforce anti-pollution laws directed toward air and water. The Clean Air Act of 1970 and the Clean Water Act of 1972 set standards and compliance procedures for industrial polluters and, for the first time, established the authority to levy fines against companies that failed to comply. As citizen awareness grew, the first Earth Day was held April 22, 1970. Citizens rallied to demand action against pollution.

In 1976, the Resource Conservation and Recovery Act established "cradle-to-grave" management of hazardous waste. Hazardous chemicals are tracked from manufacture to disposal. In 1980 the Superfund was established to clean up polluted sites.

These federal laws have continued to be refined to protect the environment. Compliance with the federal air emissions standards under the Clean Air Act required incinerators to add costly pollution control devices called "scrubbers." Many incinerators were closed rather than taking on the high cost of compliance.

The 90's

The U.S. EPA's Waste Management Hierarchy established the following list as a goal for dealing with solid waste:

- Reduce waste by preventing its creation
- Recycle and compost as much waste as possible
- Incinerate waste or treat it in other ways to reduce its volume
- Landfilling waste is last in the list of options.

Currently, the United States recycles about 14 percent of its solid waste. The U.S. EPA's goal is for 25 percent of our solid waste to be recycled by 1995. South Carolina's Solid Waste Policy and Management Act aims for 25 percent of the state's waste stream to be recycled by 1997, and our current recycling rate is 16 percent.

The U.S. EPA says that we should be recycling 25 percent of all our solid waste.

Today there are about 2,000 cities set up to compost yard waste. In South Carolina, yard wastes are banned from trash pick up containers as of May 27, 1993.

Environmental laws and regulations are frequently in the news as local, state, federal, and world leaders sort through the measures necessary to protect the environment.

In 1992, more than 170 nations sent delegations to the Earth Summit, the United Nations conference on environment held in Rio de Janeiro, Brazil.

The total U.S. costs for pollution control are projected to reach about $160 billion by the year 2000, according to the National Association of Manufacturers.

Action for a cleaner tomorrow.

A South Carolina Environmental Curriculum

For more information about South Carolina and the environment, call the
South Carolina Department of Health and Environmental Control at
1-800-768-7348.

Stick 'em Up

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 4 – 5
Focus: Airborne Pollutants
Subject: Science, Social Studies
Materials: See list below.
Teaching Time: Two class periods, about a week apart.
Vocabulary: smog, airborne, particulate matter

Learning Objective

Students will:

- learn that tiny particles are forever floating around in the air we breathe
- collect, observe, and analyze these particles from various locations around their school or community.

Background

The air around us is invisible. It is made up of gases that cannot be seen. Many major air pollutants are also invisible gases. In some areas of the country, these air pollutants can build to levels where they can be seen. For example, in some California cities, smoky, yellowish clouds of primarily car exhaust build up to create **smog**.

Other easily visible air pollutants, called **particulate matter**, are made up of tiny particles of solids or droplets of liquids. Some of these particulates are naturally occurring and may pose less of a problem to human health than do man-made particulates. Some of the natural particulates include pollen, wind-blown dust, or volcanic ash.

Man-made particulates are generated by coal and oil-fired power plants and manufacturing plants, automobile and diesel fuels, and fireplaces and wood-burning stoves among others. These **airborne** particulates, or particles carried through the air, can be harmful to plants, animals and humans. Buildings and statues can be discolored.

Questions for the Class

1. Can we see air pollution? How do we know that air pollution exists?

2. Give examples of visible air pollution.

3. Discuss the concept of particulate matter.

4. List some sources of air pollution, both visible and invisible. Can a single source provide both visible and invisible air pollution?

Materials

- Stick 'em Up sheet (included) of particulate collectors
- scissors
- clear tape
- string
- hole punch
- magnifying glasses (microscopes optional)
- marker

Learning Procedure

1. Copy the Stick 'em Up sheet (included) so that each student has a particulate collector.

2. Cut four holes ± 1.25" in diameter in the strip as marked. Using the hole punch, make a hole in the top and tie the string into a loop.

3. Cover one side of the strip with clear tape so that

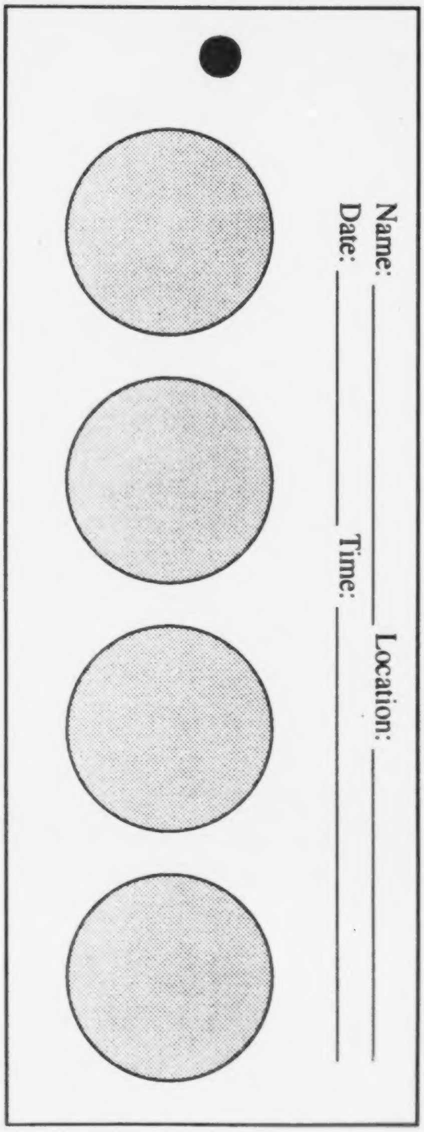
DOWN TO EARTH

United States' emissions of sulfur dioxide and nitrogen oxides in the Midwest and Northeast account for about half of the acid rain falling on eastern Canada. Much of acid precipitation falling on Scandinavian countries comes from Britain, Eastern Europe, and the former Soviet Union.

The Information Please Environmental Almanac, 1993

the holes are covered on one side. DO NOT TOUCH THE STICKY SIDE OF THE TAPE THAT IS SHOWING THROUGH THE HOLES.

4. Select different sites around the school to hang the Stick 'em Up collectors. On each strip, record the student's name, location, date and time it is hung. Site selections may include inside your classroom, in the hall outside your classroom, in the gym, bathrooms, cafeteria, office, teacher's lounge, outside near a tree, near the parking lot, etc. These should be placed where they can hang freely, not touching other surfaces and where they will not be touched by other students. Be sure to let the custodial staff know about this, too.



5. After a week, retrieve the Stick 'em Up collectors and analyze. First have the students do a cursory inspection, reviewing the strips with the naked eye. What did they find? Next, have them inspect the strips with the magnifying glass or, if you have microscopes, use them instead. What did they find?

Extension Activity

Make a traffic survey. Pick a location where students can observe a busy intersection from a safe distance. Separately record the number of trucks, cars, buses, vans, taxis that pass through that intersection in a given hour. Try this over several days at different times of days.

Ask: What factors influence volume of traffic? *(locations of highways, number of people in the community, shopping centers, businesses, special events, etc.)*

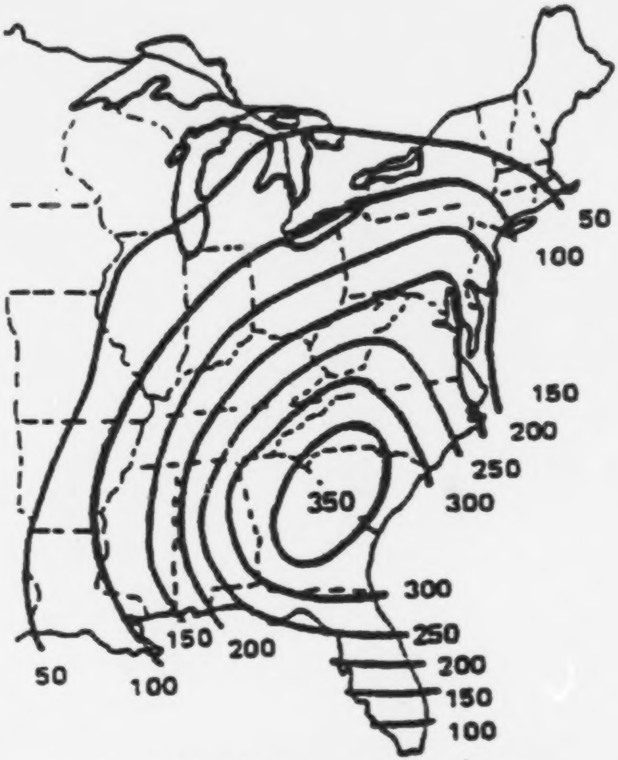
Ask: Did you see evidence of air pollution? *(smells, smoke, wilted plants struggling to survive etc.)*

Ask: Do you think this is a problem? why or why not. If so, what do you think should be done to correct it?

Today's Forecast ...

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 4 – 5
Focus: South Carolina weather patterns
Subject: Science, Social Studies, Geography
Materials: See list below.
Teaching Time: One class period, plus five days of observations
Vocabulary: topography, stagnant, altitude



Number of days with stagnant weather conditions during the 30-year period, 1936 - 1965.
This is the latest information available as of 1995.

Learning Objective

Students will:

- study weather patterns typical in South Carolina.

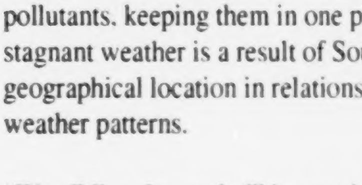
Background

Weather patterns are the single most important factor in the movement of airborne air pollutants. In South Carolina, stagnant air is a prevalent phenomenon that often results in hot humid weather during the summer months. Stagnant air traps air pollutants, keeping them in one place. The cause of stagnant weather is a result of South Carolina's geographical location in relationship to prevailing weather patterns.

"We all live downwind" is a saying that has particular relevance in South Carolina. Airborne pollutants can travel great distances ... downwind. Some of the air pollution found in South Carolina comes from the Midwest and the Ohio Valley. These pollutants are the ones that form ozone. Several years ago, severe forest fires in West Virginia blanketed South Carolina with smoke and soot.

The **topography** of South Carolina is divided into two distinct areas commonly known as the Piedmont and the Coastal Plain. The line dividing these two regions runs from the eastern border of Aiken County through central Chesterfield County to the North Carolina border. Along this line, elevation begins at about 3,000 feet and increases in steps of more than 1,000 feet in the extreme northwestern counties with isolated peaks of 2,000 to more than 3,500 feet above mean sea level.

East of the line there is evidence of outcroppings from the lower Appalachian mountains in a ridge of low hill and broken country between the Congaree River and the north fork of the Edisto River. It is also seen in a rather hilly and rolling region in the upper Lynches River drainage basin between the



In California, emissions of volatile organic compounds (VOCs) from consumer products such as charcoal lighter fluids, automotive brake cleaner, and disinfectants make up 10 percent of the total nonvehicular VOC emissions. This is about 200 tons per day.

The Information Please Environmental Almanac, 1993

Catawba-Wateree and the Great Pee Dee Rivers. In about one-third of the Coastal Plain, also known as the Upper Coastal Plain, the elevations decrease rather abruptly from 300 feet to 100 feet and lower to the coast. In the lower region to the east and south, great swamp systems predominate.

The slope of the land from the mountains to the sea is toward the southeast and all of South Carolina's streams naturally flow toward the Atlantic Ocean.

The South Piedmont section of South Carolina is on the eastern slope of the Appalachian Mountains. To some extent, these mountains act as a barrier for the wind and tend to protect the area from the full force of cold air masses during winter months.

The relatively flat areas of the Central Plains and the coastal region allow free movement of air and effectively disperse pollutants.

The degree to which airborne waste material builds up depends largely on the weather. For instance, measured concentrations of local air pollutants may vary markedly with changing weather even though the total discharge of pollutants remains relatively constant. To evaluate the role that the weather plays in dispersing airborne pollutants, it is important to consider large and small-scale weather patterns. Large scale patterns can usually be determined from the climatological evaluations of existing weather records, available from most National Weather Service Stations. Small-scale weather patterns, on the other hand, are not always easily defined because they depend on various local influences.

Factors that determine how well the weather can disperse air pollution include:

- wind speed, direction and turbulence
- stability or, more generally, the resistance to vertical motion of the lower layers of air
- humidity, including condensation such as fog.

The success of wind in moving and dispersing air pollution is based on wind speed. The faster the wind, the faster and more widely air pollutants are dispersed. Wind direction, with its variations, plays an important role in which way pollutants go.

Stagnant air masses occur with varying frequencies in the country. South Carolina experiences one of the highest frequencies of stagnant air in the Eastern United States (see map.) Stagnant air masses can produce air pollution episodes.

Stability plays an important role in the weather's relationship to air pollution. Temperature change and **altitude** determines the stability of the atmosphere. Temperature normally decreases the higher in the atmosphere you go. This is called the **lapse rate**.

Remember that warm air rises. If lower altitude air temperature is close to the temperature of air in higher altitudes, then more energy than normal is needed to move air in its natural cycle from closer to the earth to the upper atmosphere.

When warmer air is at a higher altitude than cooler air this is called a "negative lapse rate," or "temperature inversion" that keeps cooler air closer to the ground from moving to higher altitudes. A temperature inversion can trap air pollutants near the earth's surface, keeping them from being **dispersed**, or spread out, over large areas. Shallow temperature inversions near the earth's surface may be produced nightly with light winds under clear skies. This type of inversion usually breaks up in the late morning as air near the earth warms. If the temperature inversion reaches into higher altitudes, solar heating during the day may not be enough to break up the inversion. South Carolina is subject to a 45 percent chance of inversion on a annual basis.

The role of humidity, including condensation such as drizzle, snow, or rain, does not have as great an effect as wind and stability. Condensation as a result of high humidity may cause "rain out" or removal of gaseous air pollutants and particulate matter. Fog, on the other hand, usually limits solar heating which slows down the warming of air closer to the ground and slows down the break up of temperature inversions. Air pollution may also have a direct effect on weather since it can provide particles around which fog may form.

Investigations of air pollution episodes have found all of these weather elements as contributing factors for the accumulation of unusually high concentrations of air pollutants. Light winds, stable conditions, and brief periods of fog occurring at the same time is not a rare occurrence, especially in hilly country. Experience has suggested that conditions must persist for several days before high concentrations of air pollution occur. Such persistent periods are usually associated with the prolonged stagnation of high pressure systems. In the summer, the Bermuda high is the greatest single weather factor. This permanent high usually blocks the entry of cold fronts into South Carolina.

Materials

- map of South Carolina
- the weather maps from a week's worth of newspapers
- five different colored markers
- wind speed (optional) and direction indicator
- thermometer
- barometer

Learning Procedure

1. Review with the class the background materials provided with this lesson.

2. In a wide open space on the school grounds, set up the wind speed and direction indicator, thermometer, and barometer. (Note: a wind speed indicator may not be available and can be omitted. You may use a simple weather vane and compass for the wind direction indicator.) Assign students to record the data from these instruments twice a day: once in the morning and once in the afternoon, for five days.

3. On the South Carolina map, plot the weather patterns published in the newspaper. Each day gets a different color marker. Be sure to record temperature extremes and, if provided in your paper, pressure readings.

4. At the end of the week, compare the published weather findings with your class' recordings.

Questions for the Class

1. How accurate were the published accounts of the weather based on the "reality" of the school yard weather? If they were different, discuss why they might be different.

2. How do weather patterns spread air pollution out over a large area? Is this good or bad?

3. We can't alter the weather. How can we reduce the effect of airborne pollutants?

4. Who lives and works upwind? What pollutants do they produce?

5. Who lives and works downwind? What pollutants does your community produce that travel downwind?

Extension Activities

1. Visit the National Weather Service office at your local airport or have a meteorologist visit the class. Ask your local TV weather reporter to come and speak.

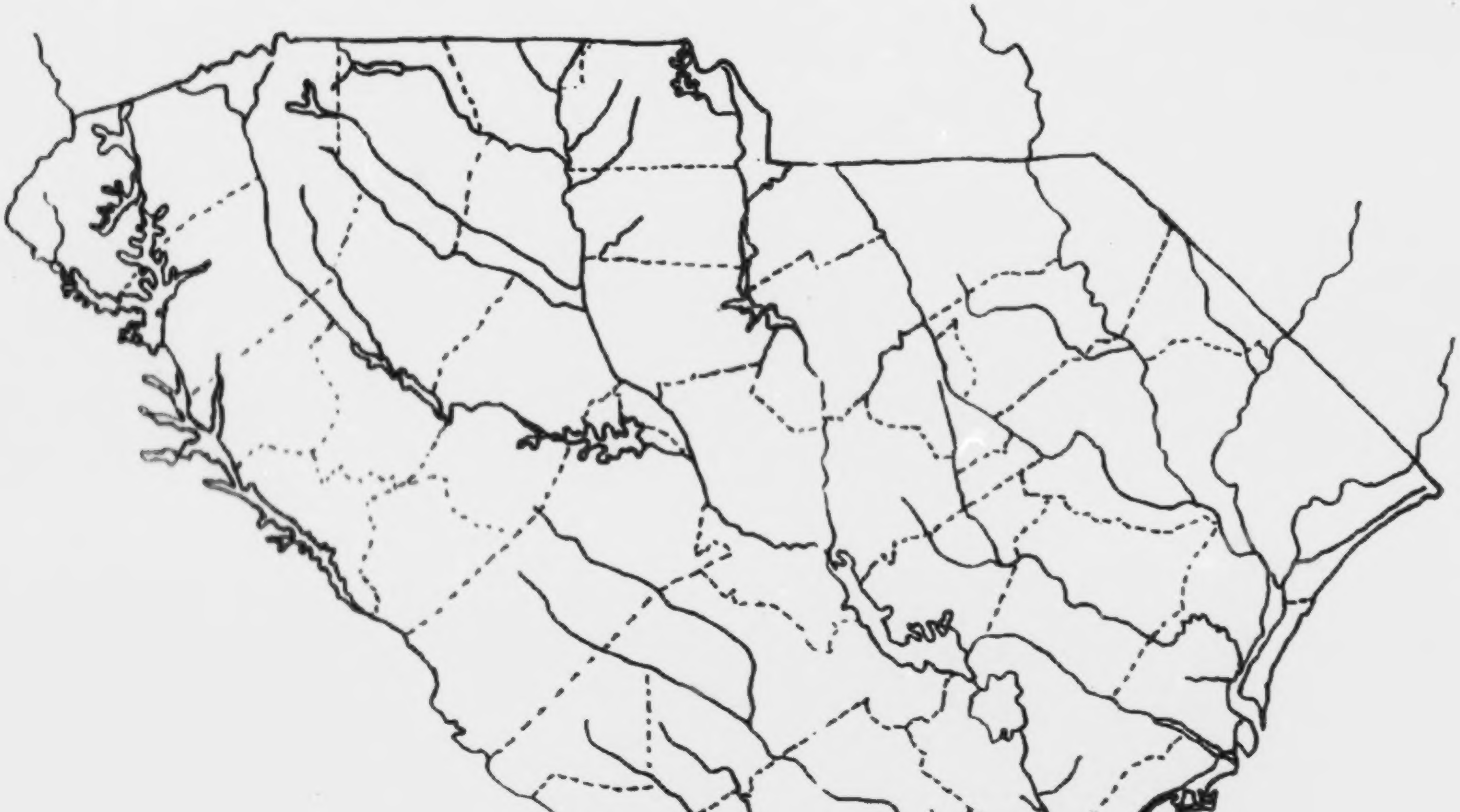
2. Using the included South Carolina map, find your county and city; identify the dividing line between the Piedmont and the Coastal Plain; and review the Background material. What conclusions can you draw regarding your air quality and topography?

Classroom Worksheet

Weather Log

	Day 1		Day 2		Day 3		Day 4		Day 5	
	Time (am)	Time (pm)	Time (am)	Time (pm)	Time (am)	Time (pm)	Time (am)	Time (pm)	Time (am)	Time (pm)
Temperature										
Barometric Pressure										
Wind Direction										
Wind Speed (optional)										

Observations:



Action for a cleaner tomorrow.

A South Carolina Environmental Curriculum

For more information about South Carolina and the environment, call the
South Carolina Department of Health and Environmental Control at
1-800-768-7348.

The Air In Here

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 4 – 5
Focus: Indoor Air
Subject: Science, Social Studies
Materials: None
Teaching Time: One class period
Vocabulary: toxicity

Learning Objective

Students will:

- learn that air pollution is not just something that happens outdoors; it's indoors, too.

Background

When you mention air pollution, students and adults usually think about emissions of automobiles, pollutants sent into the air by industry, acid rain, tobacco smoke, and burning wastes. These topics are often the focus of news reports and so they are the only kinds of air pollution we are accustomed to hearing about. However, there is also a problem on the inside. The **toxicity** of air indoors is often much greater than that found outdoors

Sources of indoor air pollution are varied: from poor ventilation to harmful vapors released by furniture and carpets; from asbestos insulation to radon gas seeping from the ground under the house; from tobacco smoke to cleaning products.

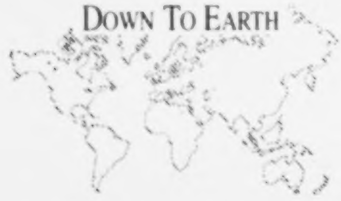
We have become more energy-efficient in recent years. This is good for the environment. However, one of the effects of this is that our homes are not ventilated as well as they were in the past. Keeping windows closed contributes further to the problem of bad air trapped indoors. This problem is not confined just to your home either. Many hotels, shopping malls, and other public buildings now have windows that do not open.

There are other factors that make us victims of bad indoor air. Pesticides, certain appliances, building materials (carpets, insulation, paint, etc.), detergents, certain perfumes, hairsprays, and cleaners are examples of products that bring harmful pollutants to the inside where they are trapped and become part of the air we breathe. Most public buildings now have bans on smoking because cigarette smoke is suspected of causing problems with those who do not smoke.

When we think of air pollution, we usually think of all the causes and forces that combine to give us a quality of air lower than we really should be breathing. Most of the publicized reports deal with the problems of the air outside. In reality, the toxicity of indoor air can be as much as 10 times the level of outside air. This is the air inside our homes, the air we breathe when we eat, sleep, and spend time relaxing with our families and friends.

There are a number of factors involved in the origination of bad air, many of which can be eliminated or reduced through simple and inexpensive common-sense steps. Others are more difficult and expensive to correct. However, if someone suffers from unusual symptoms, it might be worth the trouble to test and find out what kind of bad air may be in the home. Every home is different, and some may contain a variety of potentially harmful gases or pollutants ... some not.

In many areas of the country, but not in South Carolina, people are greatly concerned about radon.



According to the U.S. EPA, as many as 140 million people in 1990 may have lived in areas that had ozone levels, or smog, in excess of national standards.
The Information Please Environmental Almanac, 1993

Radon is a colorless, odorless, inert gas that is released when uranium-laced soil decays into radioactive particles. Radon levels vary from day to day depending on the moisture content of the soil and changes in ventilation. Homes that are susceptible to radon exposure have basements, not a common home feature in South Carolina; or homes built on a slab of concrete poured directly onto the ground. Homes with a crawl space, like most houses in South Carolina, have adequate ventilation to remove any build up of radon.

Asbestos is another common source of indoor air pollution. For many years, asbestos, a fibrous mineral that will not burn readily, was used in homes, schools, and offices as fireproofing and electrical insulation. We have since learned that minute particles of asbestos can flake off, becoming airborne where they can be breathed by the occupants of the building. Asbestos has been found to cause cancer and is therefore no longer used in new construction. However, many older building still have asbestos in them. Building codes require that, if any renovations take place in an older building and asbestos is found, it must be removed from the building before renovations are completed.

Questions for the Class

1. Some people are more at risk from indoor air pollution than others. What additional risks are posed to the elderly and to young children when they are exposed to a continued assault of bad air?

2. What effects will a depleted ozone layer pose to indoor air pollution?

3. Discuss the health problem known as Chemical Hypersensitivity Syndrome (CHS) where, in extreme cases, sufferers often have to live in a "bubble" or an environment where the atmosphere is constantly and thoroughly cleaned of all chemicals and pollutants. What are the health risks to those with CHS?

Learning Procedure

1. Share the Background material with your students.

2. Divide them into groups and have one group survey their homes and the other survey the school. Make sure they record evidence of good ventilation as well as bad; and point to specific products and materials that are harmful to the indoor environments that are part of our lives on an almost daily basis. Have them report their findings to the other group.

3. After hearing the group reports, discuss as a class or write a report on where they contribute to indoor air pollution and where they can make a difference in the indoor air where they live and learn. "What can you do to help make your own indoor environment safer and less polluted?"

4. Point out examples of specific household products that may contribute to bad air in the home. This is more of an assessment than anything else and discussion can lead to questioning whether substitute products might be used, or the use of certain products eliminated altogether.

5. As a class, brainstorm ideas that can be used around your school, or at home, to improve indoor air. Elect two representatives from the class to present your survey findings and your list of suggested solutions to your school improvement council or your principal. Take these ideas and use them at home. Ideas may include:

- spend more time outdoors
- make use of air cleaners and air purifiers
- avoid the use of halon fire extinguishers
- take steps to provide better ventilation in your home and classroom
- avoid use of highly toxic cleaning agents, drain cleaners, furniture polish, pesticides, fabric softeners, disinfectants, perfumes, and hair sprays.

Extension Activity

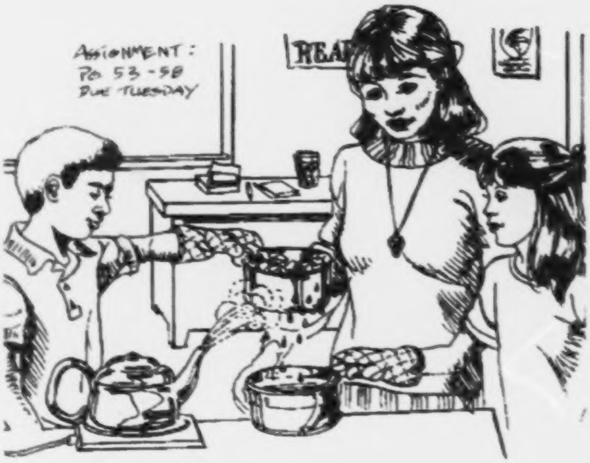
Research Chemical Hypersensitivity Syndrome (CHS). When did this first show up in the medical field? Which chemicals are most harmful to people who suffer from CHS? Where are these chemicals found? How do sufferers cope with their allergies? What can be done to help them? Why are they sensitive to chemicals? Is there anyone in your community who suffers from CHS?

4.nps.3

Nature's Water Wheel

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 4 - 5
Focus: How the water cycle works.
Subject: Science, Social Studies
Materials: Tea kettle of water, hot plate, pan of water, pan of ice cubes, pot holders, "Nature's Waterwheel" transparencies and/or handouts
Teaching Time: One class period
Vocabulary: Hydrology, condensation, evaporation, groundwater, water cycle, hydrologic cycle, infiltration, precipitation, water vapor, surface water, water table, pollution



Learning Objective

In this activity, students will help create a model and demonstration of the water cycle. Students will:

- see how nature's water cycle works.

Background

Hydrology is the study of the movement and distribution of waters of the earth. In nature, water circulates through a system called the **water cycle** or **hydrologic cycle**. This cycle begins when heat from the sun causes ocean water to **evaporate** and become **water vapor**. The atmosphere holds the water vapor while the vapor gradually cools and forms clouds. The water eventually falls as rain or snow. Most rain and snow fall back into the oceans. But some falls on the land and flows back to the seas, completing the cycle.

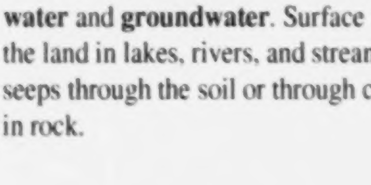
There are two main sources of fresh water: **surface water** and **groundwater**. Surface water flows over the land in lakes, rivers, and streams. Groundwater seeps through the soil or through cracks and cavities in rock.

Groundwater is water beneath the surface of the earth. It is the source of water for wells and springs. Groundwater provides much of the fresh water in the United States.

In South Carolina, about 40 percent of the population gets water from groundwater.

Groundwater accumulates chiefly from rain that filters through the soil. It also forms from water that seeps into the ground from lakes and ponds.

The surface of groundwater, called the **water table**, drops when more water is withdrawn than can be replaced naturally. **Pollution** of groundwater is a serious problem. Pollutants that seep into the ground can come from a wide variety of **point sources** such as specific chemical spills and **nonpoint sources** such as agricultural runoff and other sources that cannot be directly pinpointed.



Both of Venezuela's major lakes are polluted. After fresh water flowing into Lake Valencia was diverted for irrigation, urban sewage was the only water left going into the lake.

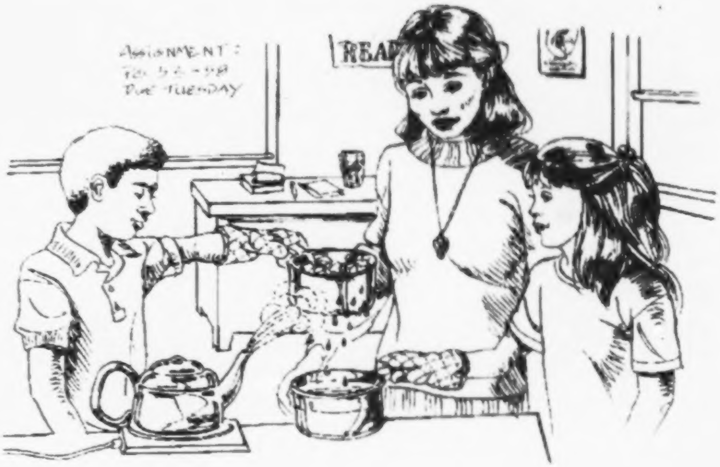
source: *1994 Environmental Almanac*

Learning Procedure

1. Provide each student with a copy of the first page of "Nature's Waterwheel" handout or use a transparency to discuss the water cycle.

2. Explain to students that you can demonstrate the basic elements of the water cycle in class. See the illustration of the setup.

Note to Teachers:
Please supervise students carefully during this demonstration. Remind students that steam is actually hotter than boiling water.



3. On a table where students can observe, place the hot plate and the tea kettle filled with water. Heat water until it boils. This heat represents the heat of the sun on the ocean.

4. Using pot holders, hold the pan of ice cubes over the steam from the boiling water. Steam from the boiling water condenses when it hits the cold ice cube pan. The condensed water then falls back into your water pan that can be poured into the tea kettle to be changed to steam again, completing the cycle.

5. Explain to students that there is more to the water cycle. Part of the cycle actually takes place under the earth, in the ground. Discuss how water eventually seeps into the soil (infiltration) and forms groundwater.

6. Have students refer to the second page of the handout, "Nature's Waterwheel," and complete their diagrams as you discuss the elements of the water cycle.

Questions for the Class

1. In the demonstration, what represents the sun? *(The kettle of boiling water. It is the heat source.)*
2. What represents the clouds? *(The outside surface of the pan of ice cubes. It is where the water vapor condenses.)*
3. What represents the rain? *(The water droplets falling from the pan of ice cubes.)*

Just Do It

Next time it rains, observe where water falls in your yard and where it runs off. Is this a possible site of contaminants from fertilizers, pesticides, or improper dumping? If so, see what can be done to clean up the area.

Extension Activity

To show students how water enters the ground, have them participate in the activity, Groundwater & Pollution. In this activity, students will prepare a model of groundwater and the water table. For an illustration of the setup, see the handout, "Groundwater & Pollution."

Materials

For three groups of students:

- three clear jars (2 liter plastic soda bottles with the tops cut off work well)
- small rocks
- rubber bands
- potting soil (about 6 cups for the soda bottle containers)
- sand (about 6 cups for the soda bottle containers)
- soil from school yard (about 6 cups for the soda bottle containers)
- three 12" x 12" (30 cm x 30 cm) pieces of screen
- three beakers or measuring cups
- three clear plastic cups
- food coloring: red or orange
- water
- three rulers
- clock with a second hand
- copy of "Groundwater & Pollution" directions, one per student
- data-capture sheets, one per student.

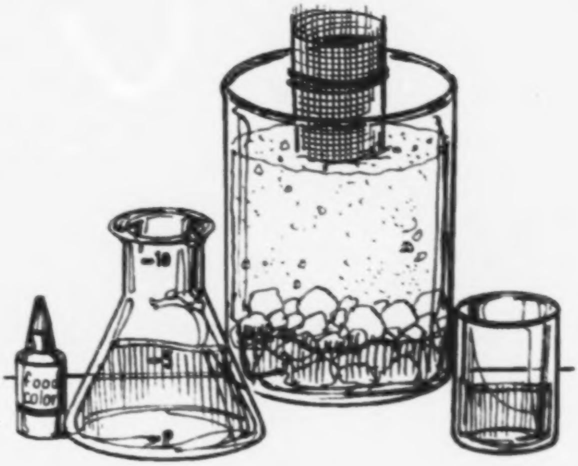
Learning Procedures

1. Divide your class into three groups. Each group will be making a model of how water from the water cycle moves underground. Each group will have a different type of soil to test, but the amount of water added will be the same.

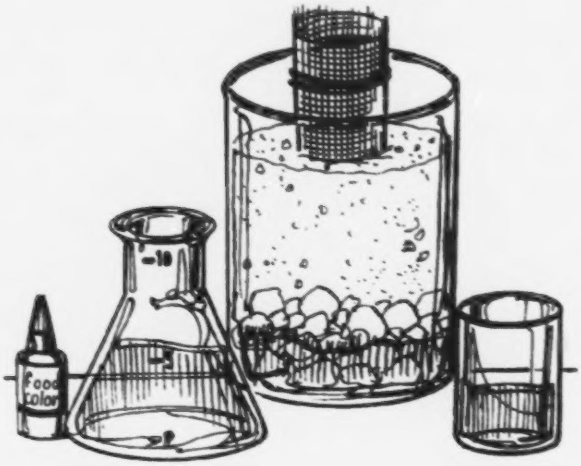
2. Give each student a copy of the "Groundwater & Pollution" handout, three pages, with directions for building their model. Be sure to assign a certain type of soil and have the groups write their soil type on their directions sheet. Once the models are completed, bring all three together to make predictions about what will happen to water when it comes in contact with the soil. Have students record their predictions at the bottom of the directions sheet.

3. Now explain to students that they are going to simulate rain fall and see what happens to the rain that falls on land.

4. From this point, all students must pour the water onto their models at the exact same time and then record observations at regular intervals. Although students have mixed up 6.5 oz (200 ml) of colored water, only 5 oz (150 ml) should be poured on the model. The remaining 1.7 oz (50 ml) in the clear cup can be used for color comparison in the analysis of the model. It is best if one student pours the water, another student watches the clock and calls out the time, and the other students record observations. Observations should be recorded on their first data-capture sheet and then questions answered on their second data-capture sheet.



Groundwater & Pollution



Materials needed:

- large container
- soil your group will be using
- piece of screen
- rubber band
- ruler
- beaker/ measuring cup
- food coloring
- rocks
- clear plastic cup

READ ALL THE DIRECTIONS BEFORE BEGINNING TO BUILD YOUR MODEL.

Procedure (Student Instructions)

1. Roll the screen into a tube with a diameter of about 2" (5 cm) and secure with a rubber band. This will represent a well.
2. Place the tube into the container vertically. One person will need to hold the tube in place while the others continue building the model.
3. Gently cover the bottom of the container with the small rocks so that the rocks are about 2" (5 cm) deep.
4. Pour enough water into the model so that the water level is about 3/4" (2 cm) deep. This will represent groundwater.
5. Pour on enough of your soil so that it is 8" (10 cm) deep.
6. Release your screen tube. At this point the rocks and soil should be surrounding the tube and holding it in place.
7. Fill your beaker with 6.5 ounces (200 ml) of water. Add five drops of red food coloring. Swirl to mix. DO NOT ADD THIS WATER YET. This will represent your "polluted" water. Pour off some of the water into a clear cup, leaving 5 ounces (150 ml) of colored water in your beaker. Keep both samples of the liquid.
8. Bring your model to the front of the classroom for display.

During the next step, each group will be pouring 5 ounces (150 ml) of red water on their model. What do you think will happen? Write your prediction below for each model:

Sand ____

____

School Soil ____

____

Potting Soil ____

Type of Soil: ____________

student worksheet

Groundwater & Pollution

You will need to record observations from the time you pour your colored water on until the end of this sheet. Write specific details about depth of water from the soil surface, color of "groundwater," changes in the "well." Remember: Only pour 5 ounces (150 ml) of your water; you need 1.7 ounces (50 ml) left over to compare the color changes.

Start: Slowly pour in 5 ounces (150 ml) on the model. DO NOT POUR ANY WATER DOWN THE WELL, pour along the sides distributing water evenly.

Start	Depth from Surface	Color of Groundwater	Changes in the Well	Other
15 sec.				
30 sec.				
1:00				
1:30				
2:00				
2:30				
3:00				
3:30				
4:00				
4:30				
5:00				
7:00				
9:00				
12:00				
15:00				
30:00				
60:00				

Groundwater & Pollution

1. At what time was the "polluted" water seen in the groundwater?

2. At what time was the "polluted water" seen in the well?

3. When did you notice the biggest changes in your model?

4. At what time did the changes start slowing down?

5. How could you have changed this model to make the water infiltrate faster into the soil?

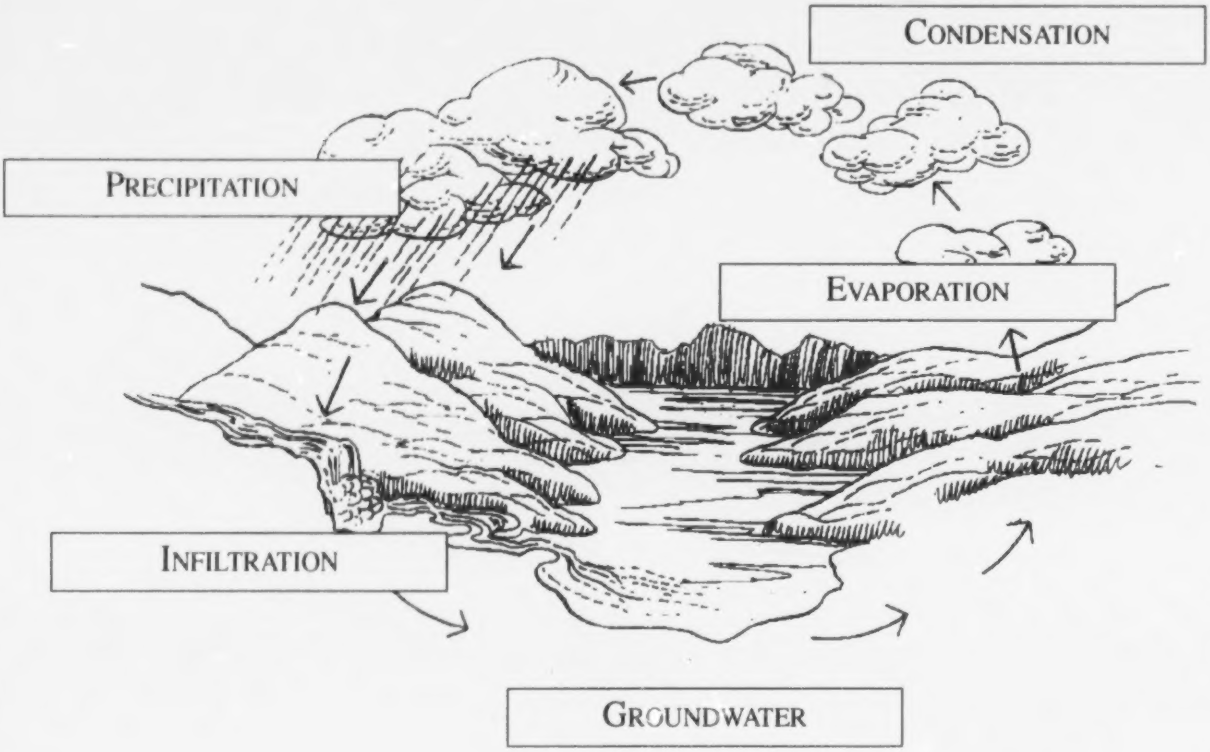
6. How could you have changed this model to make the water stay in the soil longer and not contaminate the groundwater?

7. How did the color of the water in the model compare to your leftover 1.7 ounces (50 ml) of "polluted" water? What were the changes? If there were changes, why do you suppose there were changes?

8. What does this model show you about the relationship of water pollution above ground, and in the groundwater?

9. If you lived on this land, how would your drinking water have been effected?

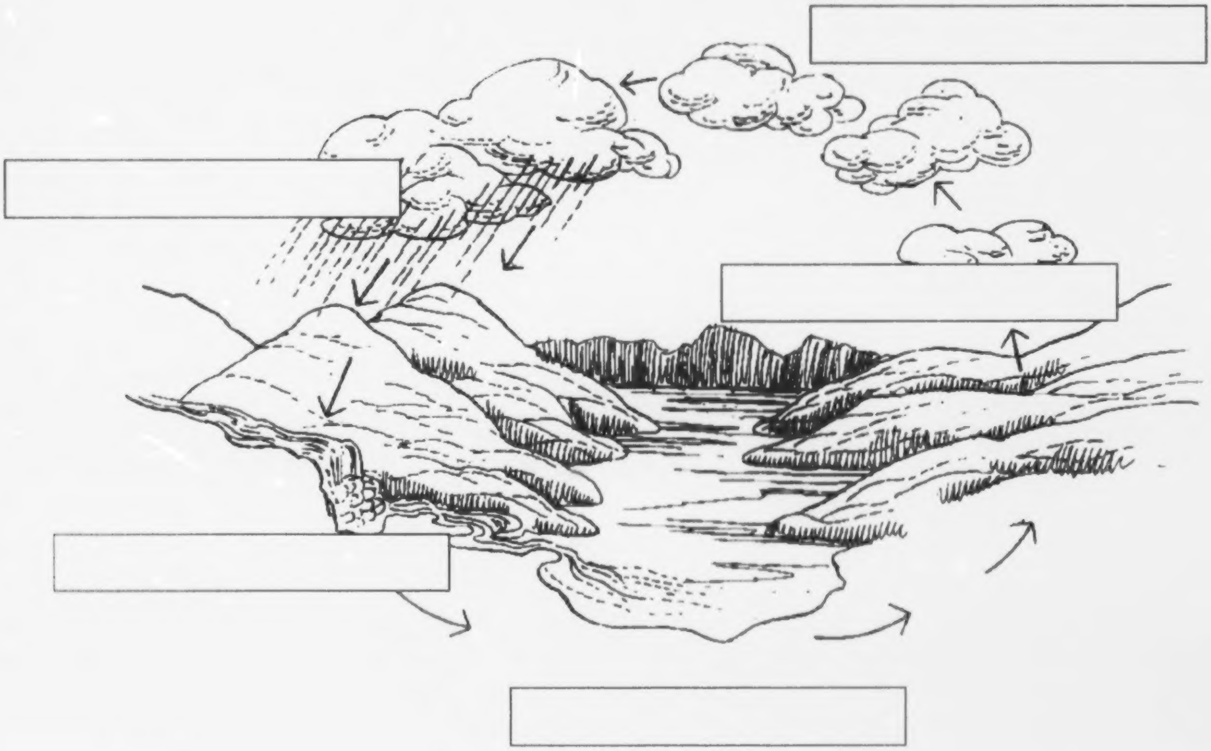
Nature's Waterwheel


CONDENSATION
PRECIPITATION
EVAPORATION
INFILTRATION
GROUNDWATER

WATER CYCLE　HYDROLOGIC CYCLE

Think about the water on the ground. The water on the ground evaporates when the ground gets warm. Think about the warm air rising. The air and water vapor expand and rise high. The air is cooled when it rises. When air is cooled, the water vapor condenses. The water vapor condenses to make clouds. Cloud drops come together to make bigger water drops. The bigger drops are rain. Rain falls on the ground. Some of the water seeps into the soil and moves underground as groundwater. It may feed into streams and lakes. The water evaporates again. The whole cycle starts again.

Nature's Waterwheel



WATER CYCLE

Condensation - The changing of water vapor to liquid.
Evaporation - The changing of water into water vapor.
Groundwater - Water found below the surface of the earth.
Hydrologic Cycle - Process involving the circulation and distribution of water on earth.
Infiltration - The process by which water seeps into the soil.
Precipitation - Forms of condensed water vapor that are heavy enough to fall to the earth's surface, such as rain, snow, sleet, hail, and fog.

4.nps.2

Runoff: It's a City & Rural Concern

Preparation Time: Easy-To-Do Moderate **Extensive**

Grade: 4 - 5
Focus: How rain water runoff from cities or farmland can effect water quality.
Subject: Science, Social Studies
Materials: See list itemized
Teaching Time: Several class periods
Vocabulary: Runoff, watershed, pollution, nonpoint source pollution, storm drains, sewer systems, fertilizers, pesticides

Learning Objective

In this activity, students will build a model city and/or countryside and will examine them in relation to run-off problems. Students will:

- identify sources of runoff pollution and ways to reduce it.

Background

When it rains, water washes across our land taking with it many different things that can pollute our water. This water flows within a geographic area called a **watershed**.

In cities, towns, and suburbs, where much of the land is paved or covered with streets, buildings, shopping centers, airports and runways, rainwater runs off as much as 10 times faster than on unpaved land. Since this **runoff** water cannot soak into soil, it flows rapidly down **storm drains**, large concrete drain pipes under ground or through **sewer systems**, contributing to floods and carrying debris and other **pollutants** to our streams, rivers and lakes.

There are things we can do to minimize runoff such as planning and preserving vegetation along banks, adding mulch, a layer of straw, burlap, or other material on bare soil until plants begin to grow. In addition, soil can be stabilized by lining ditches and small waterways with grass.

Contractors often build a small pond to trap silt that runoff washes from construction sites. These sediment basins prevent silt from entering waterways.

Agriculture is the number one cause of **nonpoint source pollution**, that is water pollution that cannot be traced back to a single, specific source. To produce more food, farms use many chemicals, such as **fertilizers, pesticides**, insecticides and herbicides. These chemicals are important tools in modern agriculture. Plus waste from animals on farms can cause pollution.

DOWN TO EARTH

In China, the Ministry of Agriculture has written new rules for the control of farm chemical runoff and irrigation damage. Farm runoff and industrial wastewater are becoming a serious problem affecting daily life.

Source: The Information Please Environmental Almanac, 1994

Animal waste and chemicals can be carried by heavy rains into creeks, streams, and water sources where they can damage ecosystems. Preventative measures can be taken to stop runoff from entering our water sources. Leaving areas as buffers between farmland and water sources can greatly decrease the chances of agricultural runoff.

When people develop land, water quality is affected. Breaking sod, cutting forests, building cities, mining and other land uses contribute to water quality problems.

Materials

To build a model city or countryside, students will need:

- a supply of water
- a large cardboard box (one for each model you plan to build)
- garbage bags (one piece for each model you plan to build)
- jar or container (one piece for each model you plan to build to catch drainage water)
- cloth dye (powder)
- one foot square piece of grass sod (or larger based upon the size of model, one piece for each model you plan to build)
- sand
- modeling clay
- poster board
- scissors
- toothpicks
- watering can
- additional grass sod (to cut into berms)
- straw
- empty wax coated milk cartons (pint or quart size to use to make barns and buildings)
- aluminum cans (to make silos for farm)
- aluminum foil (to make paved roads and sidewalks)
- items to add to scenes such as small plastic farm animals, cars, etc.
- chocolate syrup
- colored, powdered drink mix

Learning Procedure

1. Discuss runoff and nonpoint source pollution with the class. Discuss how runoff is a concern in cities and on farms. Tell students that they are going to make models of city and rural environments to see what happens when it rains.

2. Divide the class into groups based upon the number of models being made. Each group will require some supervision in constructing the model and conducting the demonstration.

3. Students will use the sod to represent the area that is being farmed or the land where the city will reside. Have students line the cardboard box with a plastic garbage bag and place the sod in the box. The sod should be placed at a slightly sloped angle to create drainage. Create the slope by placing a three-inch layer of clay or dirt under one side of the sod.

Use scissors to cut a small, one-inch hole in one corner of the plastic bag and box at the end of the slope to catch runoff water that will drain during the demonstration. Students will catch this water in a container.

For the city, have students create buildings from milk cartons, roads, sidewalks, and parking lots from aluminum foil, etc. Students can strip away grass from sod and affix items to the ground with toothpicks. Students should note how much of the natural ground covering is being replaced by hard surfaces. Once the structure of the city is built, students may add other items to the scene such as cars, buses, etc.

For the farm, students can make a barn from a milk carton, a grain silo from an aluminum can, etc. Students should leave the majority of the ground natural to represent farm fields where crops are grown. Students may strip away grass to depict farm fields that are tilled.

4. After models are complete, have students make some comparisons, observations, and predictions before conducting demonstration.

- **Which model has the greatest area of natural ground cover?** (*The farm.*)
- **Which model would produce the most runoff in a rain storm?** (*The city would produce more runoff because rain would not be absorbed by buildings and city streets. The natural ground cover on the farm would slow the runoff.*)
- **What might be washed away with runoff from the city and farm?** (*Runoff from the city would contain oil and exhaust particles from the streets, possibly litter, over flow from sewers; pet wastes; etc. The runoff from the farm would contain fertilizers and pesticides, animal wastes, soil eroding from plowed fields, etc.*)
- **Where would the runoff go?** (Runoff from the city would go into storm drains, wash into nearby lakes and rivers, and flood into sewer systems. Runoff from farms would flow into ponds, creeks, streams, rivers, lakes, etc.

5. Have students add to their models to represent the things that can be carried away with rain runoff. To the city, have students drip chocolate syrup on streets to represent oil, a small amount of drink mix powder to represent particles, and small bits of paper to represent litter.

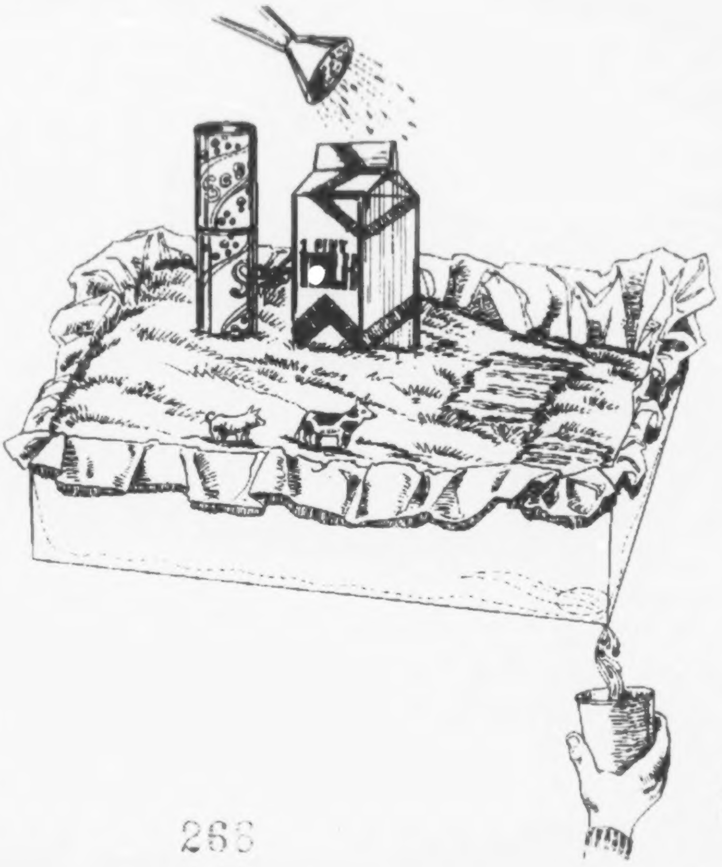
To the farm have students lightly sprinkle dye (different colors) over the sod to represent the insecticides and herbicides the farmer would apply to fields. Add a sprinkle of soil to represent the eroding soil and the animal wastes.

6. Now it's time for the rain to begin. Have a student pour clear, clean water (three cups) from the watering can over the city model. Pour slowly. Have another student positioned at the end of the box with the empty container to catch the runoff. Keep adding water until the water works its way across the city streets and down the slope and runs out of the box. Have students note the quality of the water as it runs off the model. Have them note how the rain washes away the city dirt.

Now repeat the rain pour on the farm model. **Use the same amount of water** and try to pour at the same rate. Have students observe the quality of the runoff water. The dye will color the water and demonstrate how agricultural chemicals can find their way into other water sources.

Question for the Class

1. What can people do to prevent runoff pollution? (*In cities, greenways help absorb and slow down some of the runoff. At building sites, erosion can be minimized. Along river banks, heavy vegetation and preserved wetlands help filter pollutants. On farms, chemical use can be reduced. Berms can be used to slow runoff. Animal waste can be dealt with carefully.*)

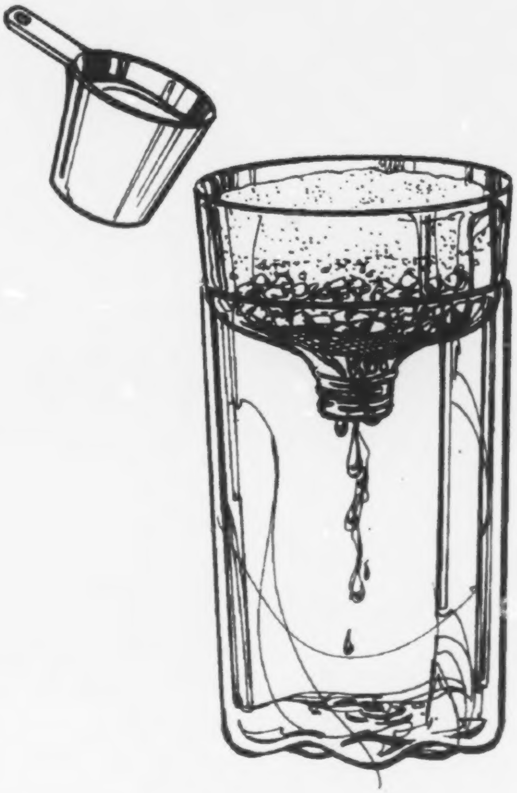


Extension Activities

1. Have students alter their models to reduce runoff. Have them add sod berms and straw vegetation, move animal pens from wash areas, and reduce litter and chemical use. Try the rain storm demonstration again and note the difference. (You may have to flush the dye away with water first.)
2. Demonstrate the soil's natural ability to filter and to purify water.

Purifying Water By Filtering It

Filtration by soil is one of the processes which purifies groundwater naturally. Filtration is used by many cities as a water treatment process.



Materials

See the illustration for the demonstration setup.

- one large glass or plastic funnel (the top of a plastic soda bottle works well as a funnel)
- small pebbles
- gravel
- coarse sand
- fine sand
- clean water
- muddy water (make by mixing water with loose fine soil)
- narrow-mouth jar (cut soda bottle)
- small piece of screen.

Learning Procedures

1. To a large plastic or glass funnel, place in the screen, add a layer of small pebbles, then a layer of gravel, a layer of coarse sand, and finally a layer of fine sand.

2. Pour some clean water through the funnel to allow the layers to settle and pack together.

3. Place the funnel in a narrow-mouth glass jar and slowly pour some muddy water into the funnel. The layers will filter the mud, and clear water will pass into the container.

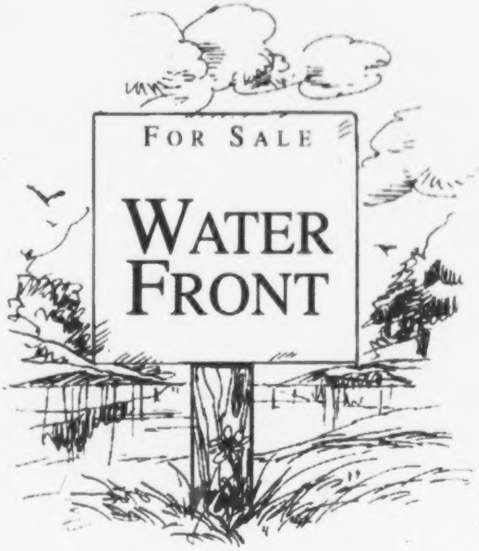
Just Do It

Check your own yard or
school yard for areas where
runoff can occur.
Try planting vegetation
to minimize runoff.

We All Live Downstream

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 4 - 5
Focus: Awareness of watersheds and who uses water along the way.
Subject: Science, Social Studies, Art
Materials: Several large sheets of poster paper, scissors, masking tape, crayons or markers
Teaching Time: Several class periods
Vocabulary: Runoff, pollute, erode, sediment



Learning Objective
Students will:

- see how we all share in the responsibility to keep our rivers and waters clean.

Background
When it rains, water washes across our land taking with it many different things that can **pollute** our water. This water is called **runoff**. Much of this pollution can be prevented by people. In this simple story-play activity, students act out life along a river and see how a few simple actions can help keep the river clean for every one to enjoy.

The culmination of individual actions can have negative or positive results. Students see evidence of this when working on group projects. When they work together and cooperate, the results are usually successful. However, if one or more of the group members do work of poor quality, this affects the outcome.

In this activity students see that when they look at a polluted river or stream, they are looking at the sum of individual actions. When a stream has been cleaned up or is kept clean, they are also looking at the results of individual actions.

The quality of water in a river or lake is to a large extent a reflection of land uses and natural factors found in a river's **watershed**. If soil near a river or lake is **eroded**, chances are the river has **sediment** problems and is not clear. If the land has stable cover such as plants, erosion can be kept in check.

When people develop land, water quality is affected. Breaking sod, cutting forests, building cities, mining, and other land uses contribute to water quality problems.

Everyone is responsible for the health of a watershed and water systems (rivers, lakes, wetlands, etc.) Individual actions, both negative or positive, add up.

DOWN TO EARTH

A train derailment in 1991 spilled toxic substances into the upper Sacramento River. The California Fish and Game Commission voted against re-opening 35 miles of the upper river for fishing.

source: *1994 Environmental Almanac*

Learning Procedure

1. Have each student bring in a large piece of poster board. Using a blue marker, have students draw and color in a river on their poster – have half the class draw in the river along the *top* fourth of the poster and have the other half of the class draw in the river along the *bottom* fourth of their poster. *(This way when students put their pieces of the river together to make a single river, you'll have a north and south bank.)* Have students number their poster in sequential order, placing numbers in upper-left hand corners of the sections.

2. Explain to students that they have each just inherited a piece of waterfront property and $1 million. Have students list ways people use waterfront property and waterways.

3. Explain that the blue on their poster is water and the blank space is land they own. Each student has $1 million to develop their land as they wish. They can build resorts, homes, hotels, factories, parks, farms, golf courses, marinas, etc., whatever they like. (You may allow them to take these home or give them time to draw in class.)

4. When students have completed their drawings , ask them to look in the upper left- hand corner of their property for a number. Explain that the pieces are actually parts of a puzzle. Starting with number 1, have them add their pieces to put together the stream where everyone can see it. Use masking tape to hold pieces together. (You'll need a large area, such as along the blackboard or a hallway.)

5. Have students describe what they did to their land, and identify if their actions could pollute or add materials to the waterway. Designate that the water will flow from left to right. As the river flows from property to property, have students discuss how water quality might suffer.

6. When students complete their river, have them represent each of their consequences to the river with an article from their desk (e.g., book, piece of paper, pen, pencil, etc.). Tell students to take their article(s) and line up in the same order as their pieces of waterfront property. They are going to pass their pollution pieces downstream just the way pollution travels. Number one will pass his or her article(s) to number two, number two to number three, and so on until the last student is trying to hold all the pieces. Have them announce what kind of pollutant they are holding before they pass it on. (For example, a marina might identify litter and oil pollution from motor boats.)

7. When all the articles have reached the end, discuss the activity. How did students toward the middle and end of the river feel? What about their property use plans? Could business downstream be affected by the actions of one upstream? Could upstream users alter the water quality of those downstream? (Discuss water quality for swimming, fishing, drinking water supplies, shell fish harvesting.)

8. Tell students to reclaim their articles. Explain that the items easily identifiable as theirs are called "point source" pollution, that is we know the source and can point to it. Other items representing pollution (pencils, paper clips, paper) may be difficult to claim. This is because the pollutant originated from multiple sources. Tell students this represents "nonpoint source" or runoff pollution.

9. Ask students what they need to do so that everyone can use the waterway and still maintain water quality. They may come up with the need to regulate what people can do with their land.

10. As a follow-up, have each student write one paragraph about what he or she would do to reduce or stop polluting.

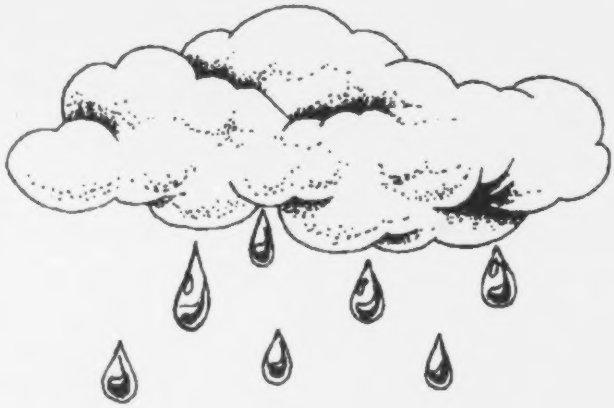
Question for the Class

1. Have students identify how the activities of individual water users contribute to water quality.

Clouds and Water Vapor

Preparation Time: Easy-To-Do Moderate **Extensive**

Grade: 4 – 5
Focus: How clouds are formed
Subjects: Meteorology, Science
Materials: Clear plastic two-liter soft drink bottle, water, matches, flashlights,
Teaching Time: One class period
Vocabulary: Matter, states of matter, gas, liquid, water vapor, condensation, cloud, fog



Learning Objective

Students will:

- review the three states of matter
- review the characteristics of solids, liquids, and gases
- observe condensation
- cause water vapor to condense and form a cloud.

Background

We have learned that anything that takes up space and can be seen, heard, smelled, touched, or tasted is called **matter**. Substances can exist in any of three different **states of matter**: **solid**, **liquid**, or **gas**. The state of matter of a substance can be changed by changing the temperature to make it hotter or colder. Besides heating, a way to make something get hotter is to compress it. With a gas trapped in a container, the way to do this is to make the container smaller. To cool the gas in a container, make the size of the container larger.

Water in its gas state is called "**water vapor**." When water changes from its gas state to water vapor (**condensation**), it starts the process as tiny droplets of water. These tiny droplets get together to form **clouds** and **fog**. We say the water vapor has condensed from vapor into fog or clouds. To change water vapor to liquid water droplets, we must cool the water. Think about what happens to your hot breath when you breathe out on a cold day. Tiny water droplets condense out of the air from your lungs. It looks like you are breathing smoke.

In order to form clouds, we also need tiny dust particles of some kind in the air. The water droplets can cling to these particles as they condense. By trapping a large amount of water vapor in a closed space and adding tiny particles which can be used by water droplets to cling together, we can watch condensation occur and create a small cloud.

Learning Procedure

1. Divide the students into small groups. Give each group a container of water, a clear plastic two-liter soft drink bottle and a flashlight. Have each team pour enough water into the bottle to just cover the bottom and cap tightly. Shake the bottle hard for

DOWN TO EARTH

West Virginia has the lowest water usage of any state: 100 gallons per person per day.

Source: The Information Please Environmental Almanac, 1994

about one minute. The hard shaking causes some water molecules to hit each other and escape as water vapor into the air above the liquid in the closed bottle. This shaking will put extra water vapor into the air inside the bottle.

2. Quickly open the bottle and pour all but about one teaspoon of liquid water out. Quickly cap the bottle so that no water vapor can escape. Make sure the cap is on very tight. Use the flashlight and shine a beam of light through the bottle. While one team member holds the flashlight, have another team member squeeze the bottle tight to make the space inside much smaller. This will make more water molecules leave the liquid state and escape into the bottle's air as water vapor. Now we should have more than enough water vapor in the air inside the bottle. **Ask:** Can you see any water vapor in the flashlight beam as it passes through the bottle? Can you see water vapor in the room around us? How can we make water vapor in the room around us condense and change to liquid water?

3. Visit each group one at a time. Carefully strike a match, let it burn for a moment and then blow it out. Quickly open the bottle cap, place the match tip near the opening, and allow the rising smoke to go inside the bottle. Squeeze the bottle quickly and release the squeeze to "suck in" the smoke. Before any water vapor escapes again, quickly cap the bottle tight. You might want to practice doing this quickly. Now we have a closed bottle with a lot of water vapor and some smoke (soot) particles. Hold the flashlight up to the bottle again and look at the beam of light as it passes through the bottle. What do you see? Again squeeze and release the sides of the bottle. What do you see now? Record your observations.

4. Discuss what is happening to the water vapor inside the bottle? What role did the smoke play in this experiment? Why did you create a cloud when you had smoke inside the bottle but couldn't create a cloud with plain water vapor?

Evaporation

Preparation Time: Easy-To-Do Moderate **Extensive**

Grade: 4 – 5
Focus: Evaporation
Subjects: Science, Meteorology
Materials: Twin sets of waterproof containers either square or rectangular, plastic rulers, calculator, water, liquid measuring devices (glass four-cup or large graduated cylinder), clear plastic wrap, rubber bands or string, masking tape, waterproof marker pens in several colors, graph paper
Teaching Time: One class period for set up, plus several days for the experiment
Vocabulary: States of matter, water cycle, evaporation, water vapor, surface area

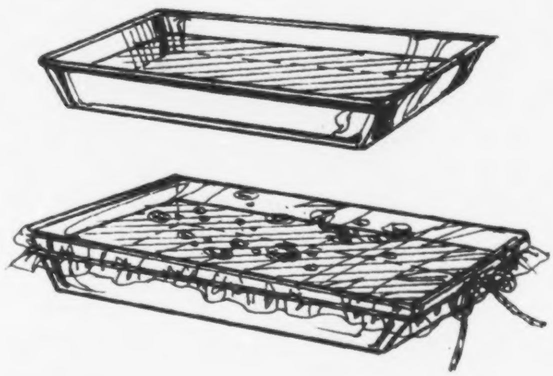
Learning Objective

Students will:
- calculate the surface area of a container
- observe and compare evaporation in different sized containers
- use the scientific method to solve a problem.

Background

Water can exist in three different **states of matter**, as a gas (water vapor), a liquid, and a solid (ice).

During **evaporation**, the water molecules no longer "cling" closely together as they do in a liquid. The molecules break free from the surface of the liquid and rise in the air as **water vapor**. The number of water molecules that are able to break free is in part dependent on the **surface area** of the container holding the water. "Surface area" is the size of the surface of the body of water exposed to the air. A large surface area at the top of the water gives more molecules room to "escape" than a smaller surface area. (Try the Extension Activity to see this principle.) Exposure to the also air helps the molecules to escape, so the more molecules exposed to the air, the greater number that can escape as water vapor.



Learning Procedure

Have the students work in teams of four. This experiment will last for five days, so the teams will need some room to set up and leave their equipment. The space should be away from sunlight and vents that might affect evaporation. Each team will need two matched containers to hold water, plastic wrap, a rubber band or string, and some water. Each team will need to label their two containers with masking tape and a marker pen.

1. Select two matched containers per team. Measure the length and width. Record each measurement. Using the formula of **Length *x* Width = Area**, calculate the surface area of your two containers. Both surface areas should be the same. Record the

DOWN TO EARTH

The U.S. EPA recommends that owners of private wells have their water tested annually for nitrates and coliform bacteria.

Source: The Information Please Environmental Almanac, 1994

numbers. Using a measuring cup or graduated cylinder, place about four cups of water inside each container. Cover one container with plastic wrap and a rubber band to seal tightly.

2. Each day for the next four days, pour the contents of the unsealed container back into the measuring cup and record the volume of water. Return the water to its container and original position on the bench. Repeat the process with the sealed container. Return the water and carefully reseal the container.

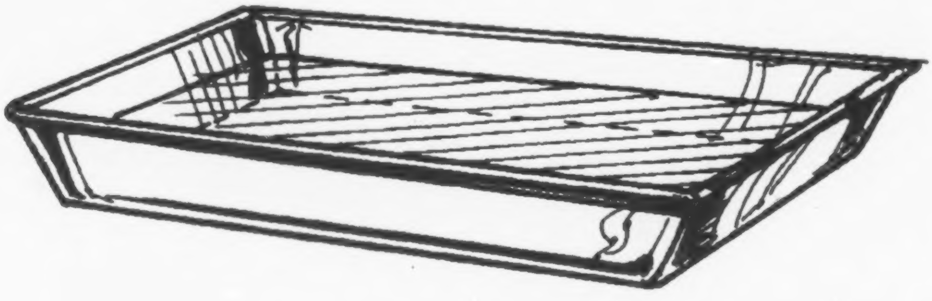
3. On the fifth day, record your final reading. Complete the worksheet provided and then graph of your results by labeling the Y-axis with the volume of water from zero to four cups and the X-axis with days from one to five. Use a different color marker pen for the unsealed and the sealed containers. Make sure your graph title includes the surface area of your containers.

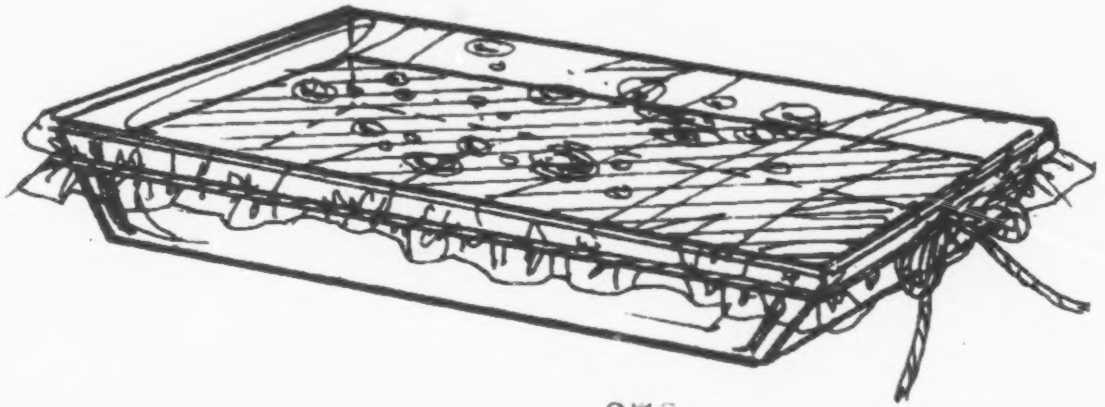
4. As a class, discuss the results and observations using the questions at the bottom of the worksheet as a guide.

Extension Activities

1. Relating surface area to number of water molecules - Draw a large square and a small square on a piece of paper. Measure the length and width and calculate the surface area. Place as many M&M candies as you can IN A SINGLE LAYER within both squares. Which square had the most surface area? Which square had the least? Which square held the most candies? Which square held the least? If the M&M's were each water molecules, which square would have the most water molecules ready to "escape" as water vapor?

2. What else affects evaporation? - Draw a square on the blackboard with chalk. Using a wet sponge, thoroughly wet the blackboard inside the square. Do not put on too much water to cause drips. Start a timer. How much time does it take for the water to completely evaporate from the square? Repeat the procedure and place a fan where it blows on the square. Start a timer. How much time does it take for the water to completely evaporate from the square? Compare time of evaporation. What made the times different?





STUDENT WORKSHEET

Name ______________________________ Date: ______________

1. To complete the table below measure your containers and use the following formula to determine its surface area: **Length x Width = Surface Area.**

Unsealed Container	**Sealed Container**
length = _______	length = _______
width = _______	width = _______
surface area = _______	surface area = _______

2. Measure the volume of water in your containers each day and record your findings below.

	Unsealed Container	**Sealed Container**
DAY ONE	4 cups	4 cups
DAY TWO	____________	____________
DAY THREE	____________	____________
DAY FOUR	____________	____________
DAY FIVE	____________	____________

3. To complete the table below, perform the following calculations: **Four Cups (Day One Amount) minus Day Five Amount = Total Water Lost**

A. Total water lost to evaporation in the unsealed container ____________.

B. Total water lost to evaporation in the sealed container ____________.

4. As a class, discuss your results.
   A. Which team had the containers with the largest surface area?
   B. Which team had the containers with the smallest surface area?
   C. Which team lost the most water to evaporation?
   D. Which team lost the least water to evaporation?
   E. How did sealing the containers with plastic wrap affect evaporation of the water?
   F. Why did sealing the container affect evaporation?
   G. From your observations, what statement can you make to relate surface area of a container to evaporation?

Action for a cleaner tomorrow.

A South Carolina Environmental Curriculum

For more information about South Carolina and the environment, call the
South Carolina Department of Health and Environmental Control at
1-800-768-7348.

Water and States of Matter

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 4 – 5
Focus: Water as a liquid, solid, and gas
Subjects: Science, Meteorology
Materials: several containers for liquids, water, several balloons, thermometer, plastic cups (2/team), ice cubes, hot plate, cooking pan, pot holder, large hand-held mirror, tin can with the top removed
Teaching Time: One class period
Vocabulary: Matter, states of matter, solid, liquid, gas, temperature, evaporation, condensation

Learning Objective

Students will:

- observe some properties of a solid, a liquid and a gas
- observe water as a liquid
- observe water as a solid
- learn how to use a thermometer by measuring the temperatures of water, ice, and the room's air temperature
- change water from a solid to a liquid
- change water from a liquid to a gas
- change water vapor to a liquid
- explore the relationship between the various states of matter using water.

Background

Matter is anything that takes up space and can be seen, heard, smelled, tasted, or touched. All of the objects in this classroom are matter. Matter can exist in several forms called states. The three states in which matter can be found are solids, liquids and gases. Things which take up space and have a definite form are called **solids**. Matter which takes up space and has no definite shape is called a **liquid**. Liquids take the shape of the container that they are in. Liquids have the ability to flow. Matter which takes up space, has no distinct form, and spreads out quickly to fill any space is called a **gas**. The three **states of matter** are related. Substances can exist in any of the three states. Substances can change from one state of matter to another and back again.

In order to change a substance from one of its states of matter to another, we need to change its temperature. **Temperature** is a measure of how hot or cold something is. Changing the temperature to colder will change a substance from a gas to a liquid and finally to a solid. Changing the temperature to hotter will change a substance back from a solid to a liquid and then to a gas.

Water is one of the few substances which can exist in all three of its states of matter at normal Earth temperatures. Water is found as a gas (water vapor) in the atmosphere, a liquid at normal Earth surface temperatures and a solid at the colder temperatures up high in the mountains or at the north and south poles of Earth.

Learning Procedure

1. Observe some common objects in the classroom. Have the students point out several things that occupy space and have a definite form. See if anyone can find a liquid in the classroom. You might want to have a clear plastic pitcher of water on your desk. Have the class observe the difference between a solid and a liquid. The pitcher and the water take up space, but the water has no definite shape. Pour the water into several different shaped containers and observe how it flows and takes the shape of the container.

DOWN TO EARTH

Mineral waters are exempt from the drinking water standards. Their main selling point — high levels of calcium and other minerals — would put them in violation of those standards.

Source: The information Please Environmental Almanac, 1994

2. Observe a balloon. Is it a solid or a liquid? Stretch the balloon with your hands. It has a definite shape, but like many solids, it can change its shape. Blow up the balloon and tie the end closed. How has the shape changed? What is preventing the balloon from collapsing back to an empty sack? What is inside the balloon? The balloon contains something that takes up space inside the balloon and takes the shape of the container it is in just as a liquid does. Now untie the balloon and hold the end open. Observe how the invisible substance coming out of the balloon has force (blows on your hand) and disperses out into the room easily. What state of matter was this substance?

3. Place the balloon in a cup or jar and inflate. Note how the balloon conforms to the shape of the cup. Also note that your can force more air into the balloon and yet it no longer expands. What happens to the extra gas forced into the balloon? Where could we find an example of a gas in the classroom? Just as the air filled the balloon, there is air filling our classroom.

4. Now consider water. What does water look like in its three states? Pour some liquid water back and forth between containers and have the students describe what they see. Pass out some ice cubes to students. What state of matter is this? How is it different from liquid water? As soon as a student says that the ice is colder, ask how we could measure how hot or cold something is.

5. Divide the students into small groups and pass an inexpensive thermometer out to each group. Pass a cup of water and a cup of ice cubes to each group. Measure the temperature of each substance. Which is colder? Which is warmer? What happens to the temperature of the ice as it sits out in the room? What happens to the state of matter of ice as it sits out in the room?

6. Compare the air in this room with the ice and liquid water. Leave a thermometer out on the desk and measure the temperature of the air. Which is warmest: air, water, or ice? Which is coldest? (You may assume that there is water vapor in the air in the classroom. However, for the purposes of this experiment, the ambient temperature and the amount of the water vapor in the classroom is insignificant.)

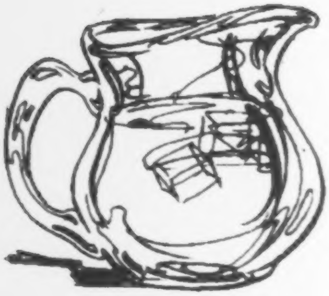
7. By simply changing the temperature, we can change the state of matter of the water. Start with liquid water and fill several containers. How could we change this water to a solid? Place these containers in a freezer (*cafeteria, teacher's lounge, etc.*) for several hours. Take out and observe the changes. Again start with liquid water. How could we change the state of matter to a gas? (*evaporation*) Pour this water into a metal pan and heat on the hot plate. BE CAREFUL OF STEAM. IT IS VERY HOT!

8. Describe what happens to the water as it gets hotter and hotter. Use the mirror to collect some of the water vapor. As the steam hits the mirror, what happens to the water vapor? Feel the surface of the mirror. Is it hot? Is it cold? What would you expect to happen to a gas when you cool it?

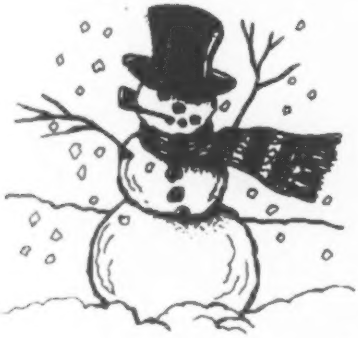
9. We know that there is a gas in the room around us. To find out if there is any water vapor contained in the room's gas, all we have to do is change the temperature of the room's air. Do we need to cool the room or heat it to change the water vapor in the air back into a liquid? What is one way we can cause the water vapor in the room to change from gas to liquid? (*condensation*) Take a tin can with the top and wrapper removed and feel the outside. Is it dry or wet? Fill the can with ice cubes. Wait one minute. Is the outside of the can dry or wet? How did the water droplets get onto the outside of the can? Where did they come from?

States of Matter

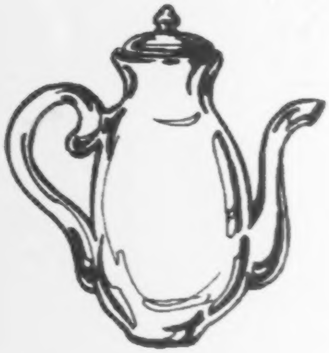
Circle the best choice



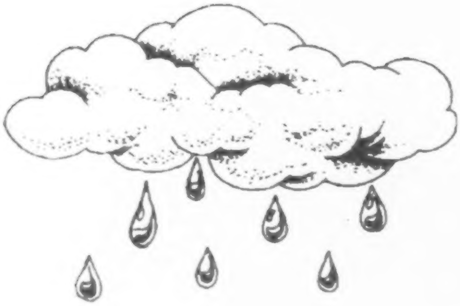
Solid Liquid Gas



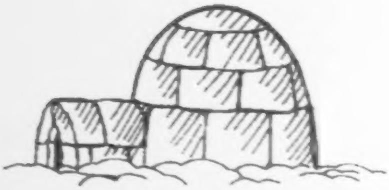
Solid Liquid Gas



Solid Liquid Gas



Solid Liquid Gas



Solid Liquid Gas

Draw Water in one of the three states of matter.

Action for a cleaner tomorrow.

A South Carolina Environmental Curriculum

For more information about South Carolina and the environment, call the
South Carolina Department of Health and Environmental Control at
1-800-768-7348.

Wells

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 4 – 5

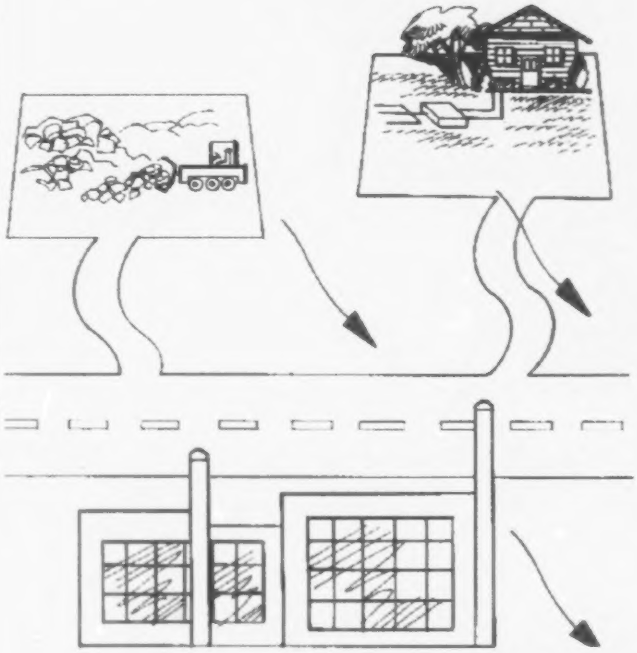
Focus: Wells and well placement

Subjects: Geology, Science

Materials: One clear plastic two-liter soda bottle and several 3 oz. paper cups per team, gravel, sand, water in pitchers, pump from a spray container, red food coloring, waterproof marker pens, well location map (included)

Teaching Time: One class period

Vocabulary: Groundwater, well, water table, recharge, contamination, groundwater flow



Learning Objective

Students will:

- prepare a well model
- observe how a well works
- observe water table levels during well pumping and groundwater recharge
- observe the effect of pollution on groundwater and well water
- decide on the best placement of a well.

Background

About half of the people in the United States get their drinking water from a **groundwater** source. Sometimes the wells are owned by a municipality and sometimes the wells are private, individual wells. In South Carolina there are about 600 community water systems that use groundwater as their source. These systems serve about 20 percent of South Carolina's population.

A **well** is a hole in the ground that is dug from the surface down to the groundwater. A well must be lined in some way to prevent the sides from collapsing back inward. This is usually done with a plastic or metal pipe and then sealed with grout. Long ago, people lined wells with stones or clay bricks.

The upper level of the water stored as **groundwater** is called the **water table**. The water table rises and falls depending on how much groundwater is drawn out and how much water goes back into the groundwater. Water that goes back into the groundwater is called **recharge**.

Well water is usually an excellent quality drinking water because water seeping downward is naturally filtered as it travels through the pore spaces in the soil to reach the groundwater. However, well water is also vulnerable to **contamination** from above the ground. Anything that is spilled on the surface can

DOWN TO EARTH

About 15 percent of Americans — 40 million people — rely on private wells, springs, or cisterns for their water.

Source: The Information Please Environmental Almanac, 1994

also make its way down into the groundwater to pollute source water for a well. Common sources of groundwater contamination include pesticides sprayed on agriculture areas, leaking septic tanks, leaking underground storage tanks, fertilizer from lawns and gardens and seepage under landfills. It is very important to dig and support a well properly. It is also important to locate a well so that it is not in an area prone to above-ground contamination. You would not want to choose the lowest part of your yard to place a well. All of the run off would flow to that point and possibly contaminate the well.

Scientists know that not only can groundwater be pumped out or recharged, but it also flows horizontally through soil and rocks. By injecting harmless dyes into wells and testing nearby wells to search for evidence of the dyes, scientists can determine which direction the **groundwater flows** and at what speed.

When picking a site in which to drill a well to use for drinking water, several things are important. The well cannot be too near to any sources of possible contamination, such as run off from pastures, highways, barns and gardens. The well also should not be placed in an area where the groundwater could possibly be contaminated from industrial wastes, landfill seepage or underground storage tank leaks.

To pick a good site to drill a well, all of these factors need to be considered.

Learning Procedure

Students should work in teams of four with each team having a clear, two liter soda bottle that has previously had the top cut off to form a cylinder with a bottom. Each team will also need gravel, sand, and a pump from a spray container.

1. Make a well model in your bottle by filling the bottom 3 inches with gravel and layering 2 inches of clean sand over the gravel. Pour in enough water to fill the bottom 2 inches of the bottle. Mark the water level on the outside of the bottle with a marker pen. This level is the top level of the groundwater. This mark represents the level of the water table, which is the level closest to the surface that the groundwater has reached.

2. Insert a pump into the soil so that it penetrates the sand and gravel layers and reaches down into the groundwater. Pump some water into a paper cup and observe the water table. What happens to the water table as the well is pumped?

3. Continue pumping water until the water table is below the tip of the pump dispenser. Can you still get water from your well? Why not? Pour some recharge water back into your model until your pump tip is again below the water table. Does the well pump water now? What observations can you make regarding a working well and the water table?

4. Mix some red food coloring in a 3 ounce cup of water and pour it into your model to simulate pollution. Wait two minutes and then pump water from your well. What has happened? Can you always tell by observation if well water is contaminated? How could you find out?

Extension Activity

Using the map and the criteria provided below, consider the following scenario and choose the best site for a well. "You live in the farmhouse and want to drill a well for your family to obtain drinking water."

1. Look at the direction of the groundwater flow. Do not put the well "downstream" of any possible contamination source.

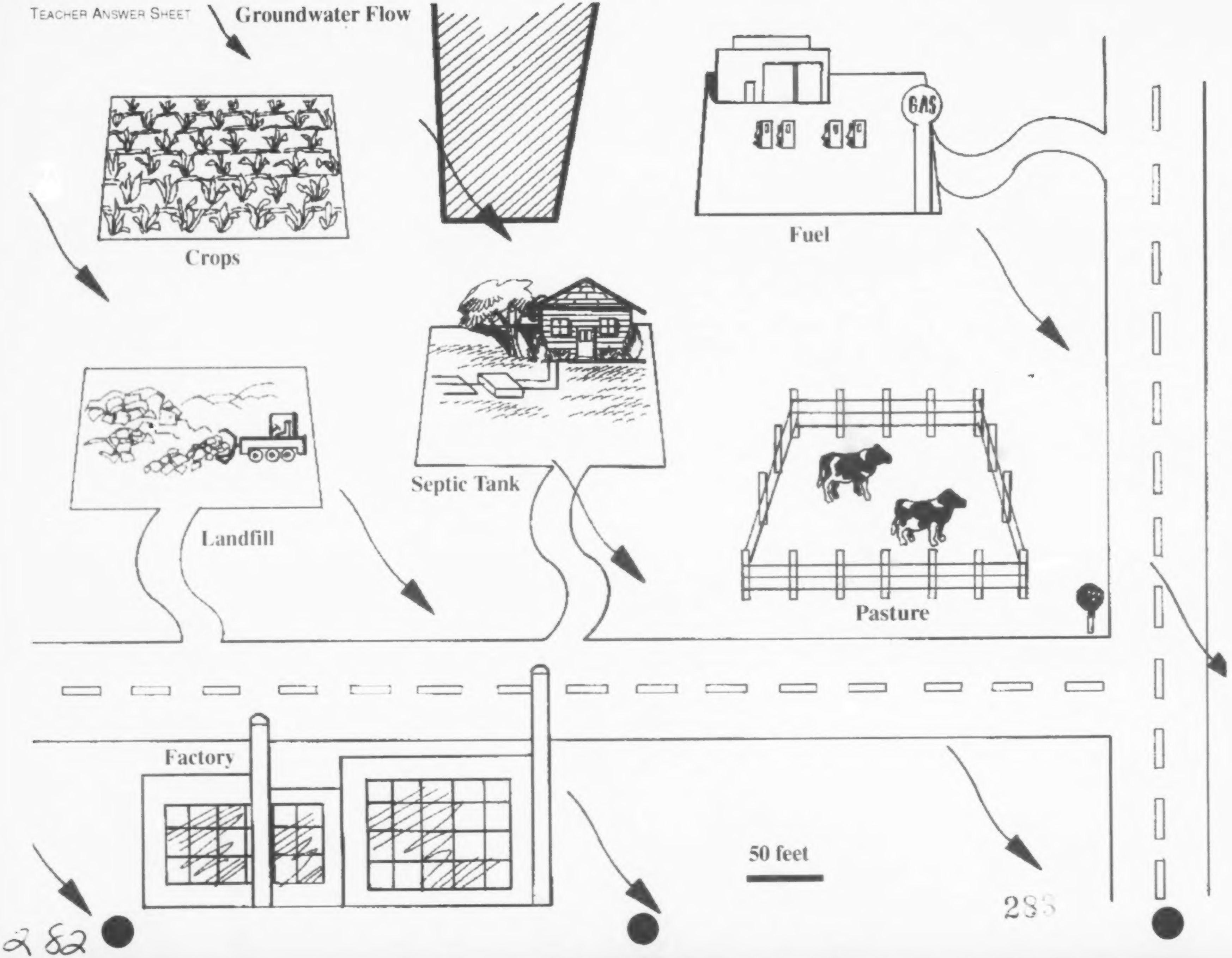
2. Make sure the well is at least 50 feet away from any septic tank.

3. Make sure the well is at least 50 feet away from any other possible source of contamination.

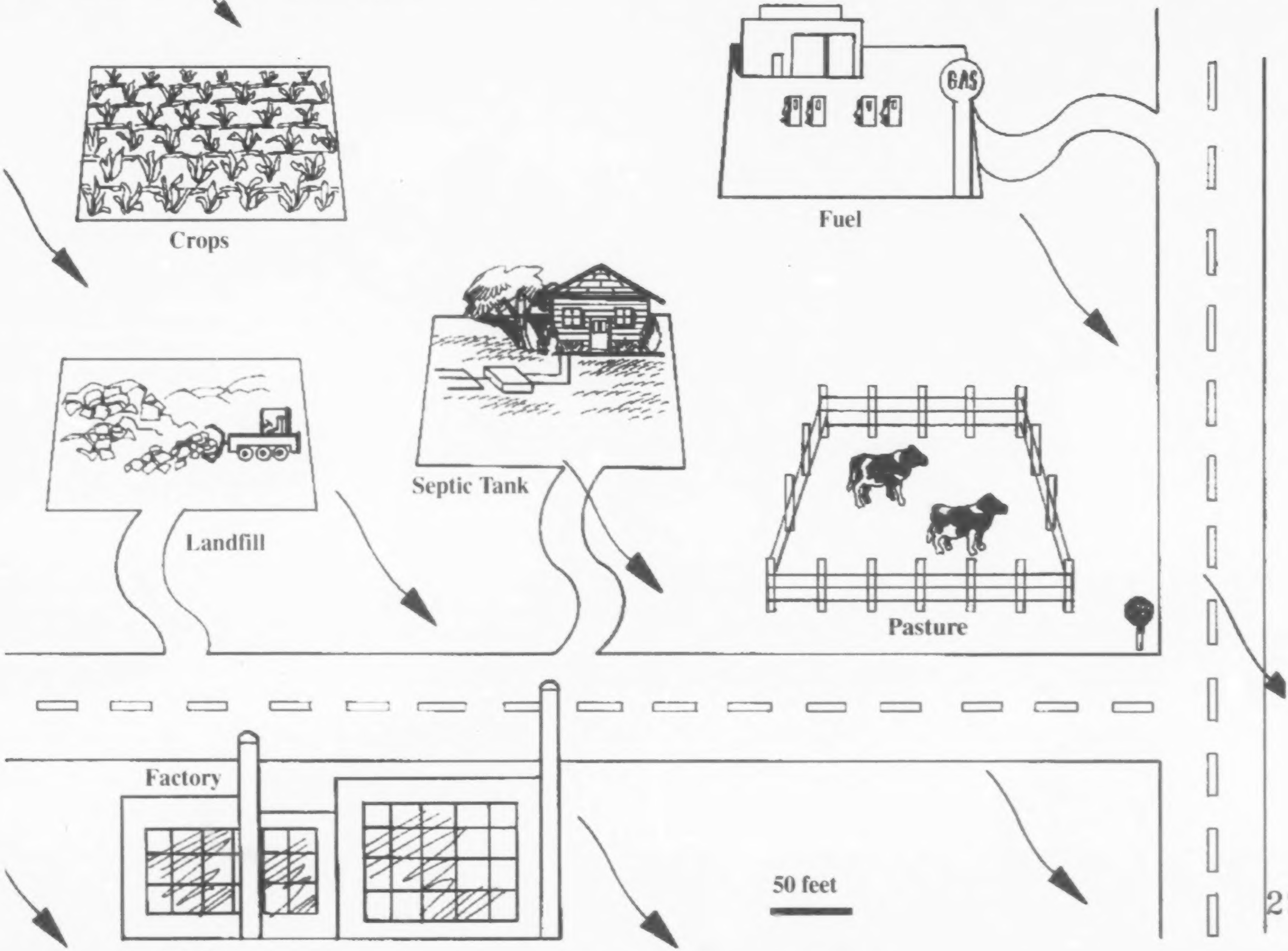
Mark the best site for the well on the map and state three reasons why you chose this site. Defend your decision.

TEACHER ANSWER SHEET

Groundwater Flow


Crops
GAS
Fuel
Septic Tank
Landfill
Pasture
Factory
50 feet

Groundwater Flow


Crops
GAS
Fuel
Septic Tank
Landfill
Pasture
Factory
50 feet

Energy to Produce Food

Preparation Time: **Easy-To-Do** Moderate Extensive

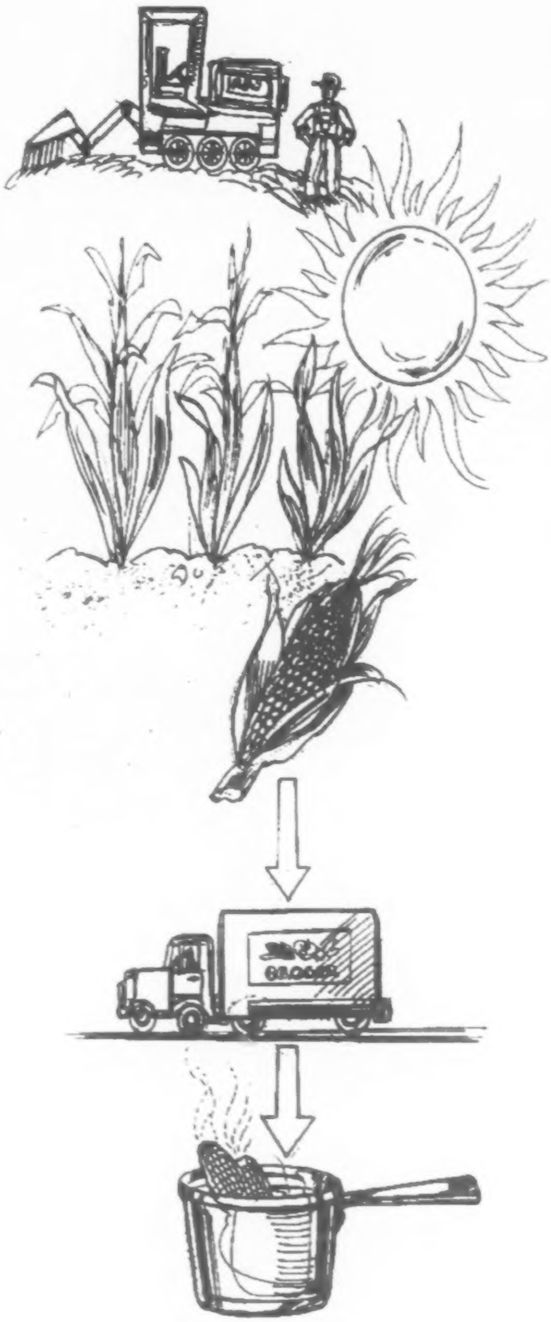
Grade: 4 – 5

Focus: How various forms of energy are used in the process of making food.

Subject: Science, Social Studies

Materials: Handout included with this lesson, art materials for making mini murals

Teaching Time: One class period



Learning Objectives

Students may associate food as an energy source for their bodies. In this activity, students will:

- trace the steps required to bring a food product to the table and the energy needed to make each step possible.

Learning Procedures

1. Ask students to list five favorite foods. Make a list of their choices. Ask students to think about where these foods come from, the ingredients that make up the food, and the energy involved in the growing, production, and distribution of these foods.

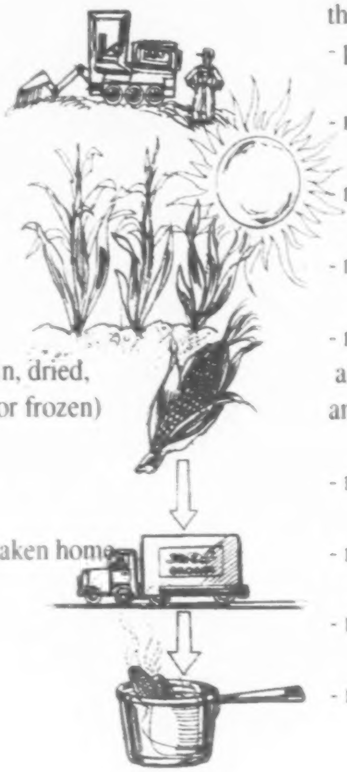
2. Select one of the foods listed by students and discuss the steps and types of energy that must be used to produce, process, distribute, and prepare the food.

DOWN TO EARTH

In the United States, producing one Btu of vegetable food energy can require eight Btus of petroleum products in its growing, fertilizing, spraying with pesticides and herbicides, harvesting and marketing.

Example: "Let's take corn and trace its steps from the seed to the table."

THE CORN	ENERGY IS NEEDED TO
a. is planted in the ground	- run the farm machinery that plants seeds and applies the fertilizer, run the irrigation equipment
b. sprouts and grows	- provide plants with warmth and light (sun)
c. harvested	- run the harvesting equipment
d. cleaned, shucked	- run the cleaning equipment
e. is taken to the market	- run the trucks to the market
f. is taken to factories (to be cleaned again, dried, or cooked,canned or frozen)	- run the trucks to the factories and to provide power for the stoves, ovens, freezers, and canning equipment
g. is transported to stores	- run the trucks that ship the corn
h. is bought at stores and taken home	- run the cars for grocery shopping
i. is put in refrigerators	- run the refrigerator and freezer
j. is cooked	- run the stoves that cook the corn



We eat the corn and get energy to do the work to start the process again.

3. Ask the students to tell what kind of fuel may have been used to provide the energy. (*Petroleum, sun, coal, wood, winds, natural gas, water, etc.*)

4. Let each student research one food. Students can then make a chart or mini mural showing the sequence of steps involved in bringing this food to the table.

5. Groups can be formed to plan an entire meal. Each food product is to be traced in the same manner. For example track the energy used in making a pizza, from growing the wheat and tomatoes to baking it.

Just Do It

Try conserving energy while preparing food at home. Use pots the same size as the burner, don't open the oven door to peek while food is cooking, and use small appliances such as electric skillets to save energy.

Conserving Energy

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 4 – 5
Focus: How insulation helps conserve energy.
Subject: Science, Math
Materials: See list below
Teaching Time: Several class periods
Vocabulary: conservation, insulation

Learning Objective

Students will:

- distinguish between electrical necessities and electrical luxuries
- survey their homes for energy efficiency
- compare insulation values of various materials
- recognize the importance of insulation as an energy saver.

Materials

- student handouts "Home Energy Conservation Checklist & Home Conservation Proposal" included
- student activity sheet "Meltdown" included
- math sheet "Insulation Percentages" included
- several thermometers for taking temperature in classroom
- ice cubes (one for each student)
- paper cups (one for each student)
- insulation materials (large enough to wrap paper cup assign students to bring these)

Learning Procedures

1. As a class, have students prepare a list of the 10 most needed uses of electricity at home. *(Note: these may include the stove, refrigerator, lights, heating, air conditioning, heating hot water, microwave, TV, alarm clocks, washing machine, clothes dryer, hair dryer, etc.)*

Discuss what life would be like without these 10 most needed uses of electricity. Are these items necessities or luxuries? *(Have the class make determinations based on their opinions. There is no right or wrong answers.)*

2. Have the class list other uses of electricity outside their home that are necessities. These might include traffic lights, hospital equipment, etc.

3. Discuss with the class that there is an alternative at home to just not using electricity, and that the alternative is ***conserving*** electricity by using energy-efficient appliances and by using them wisely.

Ask: What are examples of wasting electricity? Review your top 10 list and how electricity can be wasted by improper use. For example, running the heat with windows open, leaving lights on when no one is home, leaving televisions on when you're not watching.

4. Distribute copies of the handout "Home Energy Conservation List" and discuss. What do students think about these conservation methods? Which ones are students already doing? Which ones do they think make a difference? Which ones do they think are too much trouble or too inconvenient?

DOWN TO EARTH

Mass transportation accounts for only 6% of all passenger travel in the U.S., 15% in Germany; 47% in Japan.
source: *Energy for Tomorrow's World*

Ask students to select several of these conservation methods to discuss with their family. Use the the conservation proposal form included with this lesson and have students fill out suggestions for their family. Encourage students to take the list home.

Conserving Energy at School

5. Try to locate the areas of your classroom with the greatest heat/energy loss (during the heating season or the area of greatest cooling loss in the summer). Ask students to predict where these areas might be. Write their predictions on the board. Then place several thermometers around the classroom (by doors and windows, high in the class and low to the floor, next to an inside wall, avoid putting a thermometer next to the heating/cooling register) and assign a team of students to take readings at various times during the day (every hour works well.) Record their findings on the board by location and determine:

- Where is the room warmest?
- What is the coldest location?
- Where do you think heat is moving out of the room?
- What are your ideas for keeping heat in the room?

6. Discuss how **insulation** helps keep heat in the classroom. Insulation is any material that prevents the movement of heat.

Tell students that they are going to conduct an experiment in class testing different types of materials for their insulation quality. Assign students to bring in a piece of insulation material that they think will help to keep an ice cube from melting. This might be a scrap of cloth, plastic, paper, etc. Ask students not to bring thermos bottles or coolers.

For the experiment:

- Give each student a copy of the "Meltdown" student activity sheet to review.
- Quickly give each student an ice cube in a paper cup and instruct students to wrap the cup and cube in their material quickly.
- Have all students place their experiment cups in the same location. Remind them that the temperature in the room can vary and that this variation would effect the experiment results.
- You will need to call out the start and check times so that all students are working on the same timeline.
- Allow students to check their experiments and record results on their student sheets.
- During the experiment as students say their cube has melted, record on the board the type of insulation material and the time.

COMPARING INSULATION

Insulating Material	Melting Time

Ask the class, which ice cube lasted longer? What was the most effective insulation? What is the purpose of insulation?

Extension Activity

In this math activity, students will take what they've learned about the value of insulation and apply it to home energy Btu use. Explain that Btu is a measurement of energy. A Btu is equal to the energy released by one burning match. For example if it took 40,000,000 Btus of electricity to heat a house for one year, that would be equal to burning 40,000,000 matches.

Have students use their math skills to compute the amount of energy lost by leaks and improper insulation on the "Insulation Percentages" sheet.

You may bring in a copy of an electric power bill to show how energy is recorded for billing. Your electricity bill will use kilowatthours to measure the energy used.

Melt Down

This experiment can give you a clue about how energy used for heating and cooling your home and school can be conserved.

1. Place the ice cube in the paper cup and wrap your insulation material around the cup. Wrap tightly so that the cup can still sit upright on your desk. Do not handle your cup too much. (Remember your hands are warm!)

2. Record on the chart below the time the experiment began. Your teacher will call out this time for you.

3. Place your insulated cup in the area your teacher has set aside. (Remember temperatures vary around the class. It is important that all the cups are placed in the same location.)

4. Periodically check your cup to see how much of the ice has melted.

5. Record the progress of your ice cube. Record these stages:
    - started melting
    - melting some
    - mostly melted
    - melted.

6. Subtract the time your ice cube melted from the time the experiment began to find out how long it took your ice cube to melt.

Melt Down Record

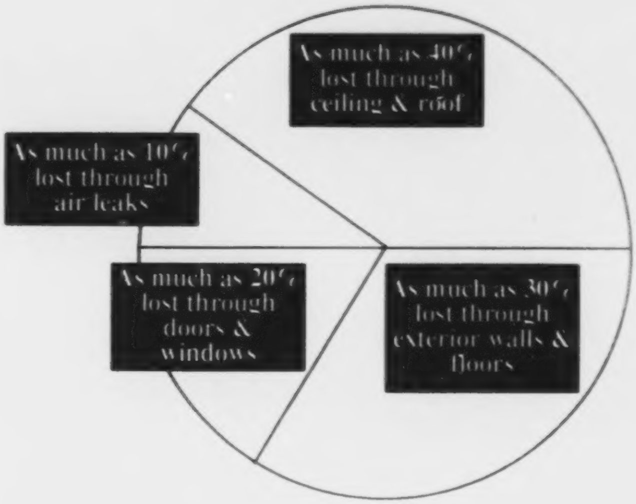
Start Time:	5 minutes	10 minutes	15 minutes	20 minutes	Finish Time:

My ice cube was wrapped in: ______________________________________.

My ice cube melted in ________ minutes.

Student Sheet

INSULATION PERCENTAGES



1 A. During the winter, the Smiths used 40,000,000 Btus of heat in their home. 16,000,000 Btus of this heat was lost through the ceiling, walls, floors, windows, doors, and air leakage. How much of this lost heat was through the ceiling and roof?
Your Answer ____________________

B. The family installed insulation in the attic which would cut the loss through the ceiling and roof to 25%. How many Btus would then be lost through the ceiling and roof?
Your Answer ____________________

C. How many Btus would be saved by this insulation in ceiling and roof?
Your Answer ____________________

D. How many Btus would be saved over the next 5 years?
Your Answer ____________________

2 A. Last year the Martins' used 38,000,000 Btus to heat their home. 15,200,000 Btus of this heat were lost through the ceiling, walls, floors, windows, doors, and air leakage. How much of this lost heat was through exterior walls and floors?
Your Answer ____________________

B. After installing insulation in the walls, the heat loss was reduced to 23%. How many Btus would then be lost through the walls and floors?
Your Answer ____________________

C. How many Btus would be saved by installing this insulation in the walls and floors?
Your Answer ____________________

D. How many Btus would be saved over the next 5 years?
Your Answer ____________________

HOME ENERGY CONSERVATION CHECK LIST

HEATING AND COOLING CONSERVATION

➲ Adjusting your thermostat is the best and least costly conservation measure. Try to get used to lower temperatures in winter and warmer temperatures in summer. See if your family will agree to lower the thermostat just 2° in winter and raise it 2° in summer. You will save 5-6% on the utility bill!

➲ Locate the thermometer on an inside wall that's not near sunlight, vents or lamps. This way you'll get an accurate reading of the temperature.

➲ Dress appropriately. Keeping comfortable has a lot to do with how well you insulate or ventilate your own body. Try loose fitting clothing, open collars and open weaves for hot weather, layers of clothes and closed collars for colder weather.

➲ In cold weather, use more blankets or a down comforter.

➲ In the winter months, leave shades, blinds, and curtains open On sunny days so you can make use of the sun's heat. Close them on cloudy days to prevent heat loss. Reverse the process in the summer.

➲ Close the fireplace damper when it's not in use to prevent heat loss.

➲ Don't cover the top of heating or cooling vents with knick-knacks, bowls or belongings. This makes it necessary to use more energy. Also, don't hide vents behind draperies for the same reason.

➲ Help cool weather to come in. The more cool air you let in, particularly at night, the better. Experiment to see which windows and doors to open or close or to create the best flow of cool air through your home.

➲ Let hot air out. Encourage your parents to open the upper vents in your attic, and make sure any lower vents are not blocked.

➲ Since hot air rises, open the upper part of double hung sash windows and, in a two story house, the upstairs windows.

➲ Let breezes in. If windows are blocked by shrubs or tree foliage, the bushes might need pruning.

➲ An exhaust fan in a window can push out warm air and pull in cool air. A window fan is more economical to run than an air conditioner. A window fan in an apartment or one story house should be in a window on the warmest side; in a two-story house, put it in an upstairs window.

➲ Use ceiling fans if you have them. In the winter run them counterclockwise to force hot air downward. In the summer, run them clockwise to circulate cooled air.

➲ If you have central air conditioning, don't close off unused rooms or shut off vents. Rather than saving energy, this makes the system work harder.

➲ It may be easier to move yourself into a warm sunny room on a cold day, say to do homework or eat a snack, than it is to move that free solar heat to a cooler part of your home. And upholstered furniture, like a big armchair or sofa, will soak up the heat very nicely when placed in a sunny spot.

➲ Encourage your family to use storm doors and windows. Make sure the storm doors are fastened tightly and the doors are closed properly

➲ When it's time to paint the outside of your home, suggest using light colors. Since South Carolina's climate tends to be warm, light-colored paint is a good choice because it reflects sunlight.

WATER HEATING CONSERVATION

- Use hot water wisely. Don't let water run while you go in the other room. Don't use hot water if cold or lukewarm will do. For example, run the garbage disposal with cool water, not warm.

- Try to get in the habit of taking a shower instead of a bath. Showers typically use less hot water. Water-saving shower heads will typically pay for themselves in a few months.

- Be on the alert for leaky faucets. A two-cent washer can save hundreds of gallons of water over the course of a year.

- Wash clothes in cold water when possible.

APPLIANCE CONSERVATION

- Cut back on the amount of water you use for boiling eggs potatoes, and other foods. The more water you use, the more energy is needed to make it boil or simmer.

- Use pots that are the same size as a burner, so that heat doesn't escape.

- Make sure pot and pan lids fit tightly This keeps heat inside. It also makes the food cook faster.

- If you have a toaster oven or electric frying pan, use it. They use half the electricity of an electric oven.

- Every time you use a microwave, you save energy. Microwaves not only cook food in one-fourth the time, they save 30-70% electricity.

- Avoid peeking in the oven. It not only makes a souffle fall, it drops the oven's temperature 25-50°F every time it's opened.

- Periodically vacuum the condenser coils on the back or bottom of your refrigerator. (Unplug it first!) Dust acts as an insulator on the cables, making the refrigerator work harder.

- Refrigerators and freezers work best when they are full. However, items need to have space between them so that air can circulate.

- Don't place hot or uncovered foods in the refrigerator. It takes increased energy to cool hot foods. Uncovered foods will lose moisture to the refrigerator.

- Test to make sure the refrigerator and freezer seals are working by placing a dollar bill lengthwise along the edge and closing the door. If the dollar falls, your appliance needs to have the seal replaced. An airtight seal helps the appliance work efficiently

- Utility companies suggest that you put petroleum jelly along refrigerator and freezer seals to make them last longer.

- Defrosting frozen foods in the refrigerator helps the refrigerator stay cool. It also uses less energy than microwave defrosting and, in the case of Thanksgiving turkey, is safer than defrosting on a countertop where bacteria might grow.

- A freezer with more than 1/4 inch of ice needs to be defrosted to save energy

- Always wait until you have a full load to run the dishwasher, washer or dryer. Full doesn't mean overloaded. Overloading wastes energy and rarely gets the job done. On a sunny day, think about using the solar dryer - the clothes line.

- Turn off the TV, radio, or video game when they're not in use.

- If you have an "instant on" TV, part of the TV is actually on all the time. One way to really turn this type of TV off is to plug it into a socket that is controlled by a light switch and to use that light switch when you turn off the set.

- Encourage your family to pay attention to the yellow energy tags and labels when buying new appliances. Comparing tags is an excellent way to help your family make an energy-wise choice. The higher the efficiency level, the greater the savings as you use the appliance.

Lighting Conservation

- Use lower watt bulbs in stairwells, closets and areas that require reading light.

- To make a room brighter, use one bulb of high wattage. For example one 100 watt bulb uses less energy than two separate 50 watt bulbs.

- Use energy-saver bulbs. These give as much light as conventional bulbs but use less energy.

- Encourage your family to use fluorescent bulbs. These tube-shaped bulbs are comparatively expensive to buy, but are long-lasting and extremely economical over the long run.

- Suggest using light-colored lamp shades. They reflect 50% more light than dark shades.

- Try placing a lamp in a corner of a room. Here, it has two surfaces to reflect off of rather than just one wall.

MY ENERGY CONSERVATION PROPOSAL

I SUGGEST THAT MY FAMILY LOOK AT THESE WAYS TO SAVE ENERGY. I'M WILLING TO DO MY PART TO SEE THAT THESE ENERGY-SAVING IDEAS WORK FOR MY FAMILY.

MY IDEAS INCLUDE:

1. ____
2. ____
3. ____
4. ____
5. ____
6. ____
7. ____
8. ____
9. ____

Living Without Power

Preparation Time: Easy-To-Do [✓ **Moderate**] Extensive

Grade: 4 – 5

Focus: How our lifestyle depends upon available electricity.

Subject: Language Arts, Social Studies

Materials: Handouts and news clips from Hurricane Hugo included with this lesson (one per student)

Teaching Time: One class period plus student writing

Vocabulary: Power outage

Learning Objectives

The affect that our use of electricity has on our lifestyle and our expectation of services are explored as students write creative stories from factual newspaper clippings.

Students will:

- identify facts in a newspaper article
- write a creative story using these facts and imagination.

Learning Procedures

1. Hand out copies of the news articles that report on Hurricane Hugo and the massive **power outages** resulting from this storm that hit South Carolina in 1989. Read aloud or have students read the articles to themselves.

2. Ask students to write their answers to the questions on the student question sheet or have students answer questions in a class discussion.

3. Ask students to imagine they are living in a house that uses electricity for heat, lights, appliances, etc. A storm occurs and knocks down the electric lines for several days. Have students write a short, creative story describing how life would be affected. Have students describe how they would spend their day – how they would prepare food, stay warm, and use their time.

4. As an art project, have students illustrate their stories.

5. Review with the class the materials from SCE&G utility company that shows how power lines distribute electricity to our homes and how downed trees can interrupt service.

Extension Activities

1. Have students rewrite their stories imagining that alternative power sources are in their home. This might include solar power heating, skylights, or their own energy "inventions", etc.

2. Have students write short compositions on energy-related topics.

Suggestions:

1. How Energy Will Affect Our Lifestyle in the Year 2000
2. The Day The Sun Stopped Shining
3. My New Electric Car
4. Blackout: In The Big City
5. My New Energy Machine

DOWN TO EARTH

Commercial fossil fuels supplied over three-quarters of the world's total energy requirements in 1990.
source: *Energy for Tomorrow's World*

Student Question Sheet

Hugo Hits South Carolina

Read the articles attached that appeared in *The State* newspaper – "Hugo: The Aftermath" graphic & "Utilities", "Powerless relying on friends' generosity", "Storm leaves trail of destruction throughout the state" – in the days following the hurricane, then answer these questions.

1. On Wednesday, September 27, 1989, *The State* reported how many counties as disaster areas?

____

2. On Wednesday, September 27, 1989, *The State* reported the estimated total damage as __________.

3. On Wednesday, September 27, 1989, *The State* published a graphic that showed how many counties damaged by the hurricane?

____

4. What are residents hit by the hurricane warned to do with their water to make it safe to drink?

____

5. In Kingsville, Lillian McFadden and her family reported that they are eating where after the hurricane knocked out her power?

____

6. On Wednesday, September 27, 1989, *The State* reported the status of the state's utilities. How many people were still out of power in Georgetown County? ______________________________

How many were out of power in the Columbia area? ______________________________

How many Carolina Power & Light customers were out? ______________________________

7. What is the longest time the power companies expected some customers to be out of power?

____

8. On Sunday, September 24, 1989, *The State* reported that Berkeley County had no water, no power, and minimal communications inside and outside the county. According to officials how long will it be before power is restored? ____________

____

9. What percentage of the structures in Clarendon County received damage? __________________

10. What did the residents of Eutawville and Holly Hill estimate caused the damage to their trees?

____

11. What two groups brought in help get water to the residents of Orangeburg County?

____

12. What were two of the most immediate needs of the people in the areas hit by the hurricane?

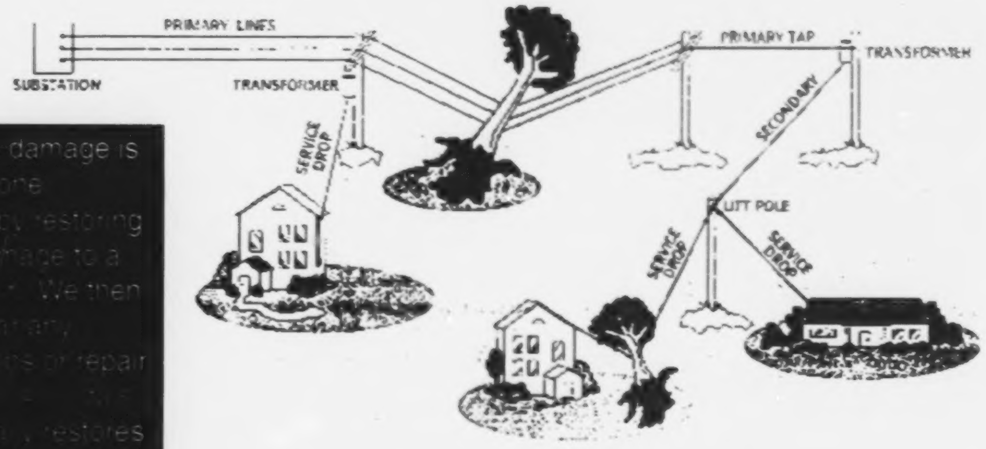
____

____

Just Do It

What is your family's plan in the event
of a power outage?
Be sure to keep candles & matches,
batteries & flashlights, and other
emergency equipment in good working
order.

Storm response begins *before* the storm.


PRIMARY LINES
SUBSTATION
TRANSFORMER
SERVICE DROP
PRIMARY TAP
TRANSFORMER
SECONDARY
UTT POLE
SERVICE DROP
SERVICE DROP

After the damage is done we start by restoring any damage to a [illegible]. We then clear any obstructions or repair fallen [illegible]. This usually restores power to most customers. Next we inspect and repair [illegible] neighborhoods. If you find yourself without power, yet your neighbor has power, it's probably because you have a damaged transformer or [illegible]. The service drop is the line that comes from a [illegible] transformer on a pole to your house.

Before you even think about a storm, we're preparing for it. SCE&G tracks weather conditions and has plans in place, so that Mother Nature impacts your electrical service as little as possible. However if Mother Nature graces us with thunderstorms or hurricanes, damage is sure to occur. Here are some things you might want to consider:

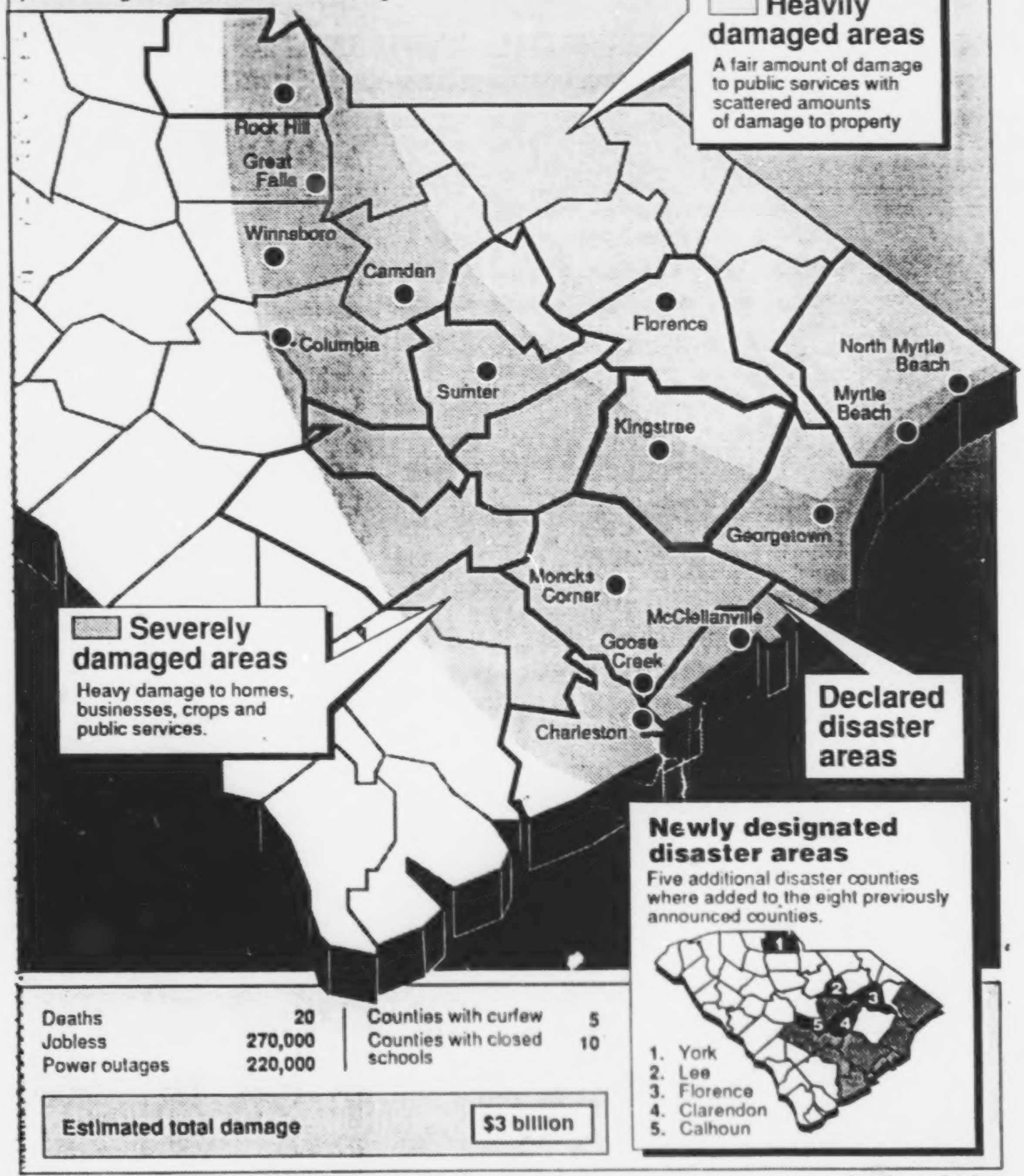
- Always keep batteries for flashlights and radios.
- Stock up on water and non-perishable food.
- Regardless of where your house number is located, mail box or curb, make sure it's very visible. This helps SCE&G as well as firefighters, ambulances and other emergency groups locate you.

SCE&G

HUGO: THE AFTERMATH

Extent of damage in S.C.

Five days after Hugo struck the coast of South Carolina, fatalities and damage estimates are still climbing.


Rock Hill
Great Falls
Winnsboro
Camden
Columbia
Sumter
Florence
Kingstree
North Myrtle Beach
Myrtle Beach
Georgetown
Moncks Corner
McClellanville
Goose Creek
Charleston
1
2
3
4
5

□ **Heavily damaged areas**

A fair amount of damage to public services with scattered amounts of damage to property

▨ **Severely damaged areas**

Heavy damage to homes, businesses, crops and public services.

Declared disaster areas

Newly designated disaster areas

Five additional disaster counties where added to the eight previously announced counties.

1. York
2. Lee
3. Florence
4. Clarendon
5. Calhoun

Deaths	20
Jobless	270,000
Power outages	220,000
Counties with curfew	5
Counties with closed schools	10
Estimated total damage	**$3 billion**

Scott Farrand/The State

Hugo: The Aftermath

The State/ Columbia, S.C.
Wednesday, September 27, 1989

Electricity

South Carolina Electric & Gas
(430,000 total customers)

- Columbia area — 19,000 customers without electricity; power should be restored by late Thursday or Friday; outages in Eastover, Hopkins (off S.C. 37), Spring Valley, Briarcliff, S.C. 21 to Two Notch Road, portions of Bluff and Broad River roads and Rosewood, Veterans Hospital, Trenholm and Rockbridge roads areas.
- Ridgeway — 175 out; 1 to 2 days.
- St. Matthews, Cameron, Santee, Elloree — 350 out; 1 to 2 days.
- Charleston —100,000 out; three to four weeks.

Duke Power

- Lancaster — serves 50,000 customers in Lancaster and Chester counties and areas south of Charlotte; about 25,000 out; two weeks.
- Charlotte — serves 235,000 customers; 60 percent out; one to two weeks.

Camden City Utility
(9,000 total customers)

- Camden — 4,500 - 5,000 out; two days to a week.

Carolina Power & Light
(140,000 S.C. customers, in Chesterfield, Clarendon, Darlington, Dillon, Florence, Kershaw, Lee, Marion, Marlboro, Sumter and Williamsburg counties.)

- 50,000 out; a week or more. More than 50 percent out in Bishopville and Sumter.

Tri-County Electric Cooperative
(12,000 total customers in Calhoun, Kershaw, Lexington, Orangeburg, Richland and Sumter counties.)

- 4,000 out; hope to have all restored by Sunday.

Fairfield Electric Cooperative
(13,000 customers in Fairfield, Chester, Richland, York and Kershaw counties.)

- 350 out, mostly in the Lugoff area; 2 days.

Pee Dee Electric Cooperative
(20,000 customers in Chesterfield, Darlington, Dillon, Florence, Lee and Marion counties)

- 7,000 out. They hope to have all of Dillon and Marion counties and 75 percent (5,000 out) of Chesterfield, Darlington, Florence and Lee counties restored by 8 p.m. Tuesday.

Santee Cooper
(85,000 customers) Georgetown County

- 70 percent out in Garden City; 70 percent, Murrells Inlet; 100 percent, Pawley's Island; two to several weeks.

Horry County

- 15 percent out in Conway; 50 percent, Myrtle Beach; 40 percent, North Myrtle Beach; 60 percent, South Grand Strand; two days, to several weeks. Berkeley County
- 5,000 out in Moncks Corner, Bonneau Beach, Pinopolis, St. Stephen; four weeks.

South Carolina Electric Cooperatives
(400,000 customers)

- Berkeley, 35,000 out; Black River, 16,000; Coastal, 50; Horry, 1,200; Lynches River, 3,500; Marlboro, 100; Pee Dee, 7,000; Santee, 24,000; and York, 6,000.
- Horry and Coastal, 2 days; Berkeley, Black River, Lynches River, Marlboro, Santee and York, a week.

Power-less relying on friends' generosity

By LORETTA S. NEAL
Staff Writer

For more than 20,000 residents of Lower Richland and Eastover, roughing it has lost its romance.

Most have been without electricity since Hurricane Hugo stomped through the Midlands five days ago, and power company officials say it could be three to five more days before the lights come back on.

They've been warned to boil their water. Ice is in short supply. The food they haven't eaten by now has spoiled. And they have to rely on friends in other parts of the county when they want to shower.

"I have had two heart attacks, and this thing (no power) is worrying me. But I have good neighbors," said 75-year-old David Crout of Reese Road in Eastover.

Crout borrowed a generator from a relative, but not before he lost all of the meat and food in his freezers.

"I went everywhere looking for ice, and I couldn't buy any anywhere," said Crout, talking above the hum of the generator.

A neighbor has been bringing him 20 gallons of water every day, however.

"They are good friends and they have been helping me and my wife, Juanita. So far we have coped, but it is hard," he said.

On McBeth Road in Eastover, Andrew McBeth is using candles for light and a friend's manual pump to get water.

"It hasn't been easy with three children," McBeth said. "I can't say we are enjoying this. To keep from losing my meat in the freezer, I cooked it all on a grill, so I don't have any more meat."

In Kingsville, Lillian McFadden and her family had no means of keeping food in the freezer and "we have lost it all." And she said eating out every day is getting expensive.

Ms. McFadden said the family, travels about five miles each morning her sister's house to dress for the day.

"It is a real hassle, but we have no choice. We are just going to have to live with it until we get power restored."

Lower Richland Boulevard resident Emily Derrick said the storm spared her home but when the power went off she lost a freezer load of home-grown vegetables and she has to drive to her sister's house in Columbia to get water.

However, life isn't as bad as it could be, especially for her two children, who have borrowed a battery powered television to help ward off boredom.

In Northeast Columbia, Jeanette Russell said she has depended on generous friends to help her cope.

"I have gotten lots of invitations out to dinners," said Mrs. Russell.

With no power, Mrs. Russell has to use candles and flashlights for light.

"I go to bed early," said Mrs. Russell. "I will never mention the old timey days again because if this is the way it was, I don't like it."

Storm leaves trail of destruction throughout the state

excerpt from *The State* newspaper

Berkeley County

While historic Charleston was the focus of much of the coverage of deadly Hurricane Hugo, neighboring Berkeley County may be the unknown victim.

Saturday, the county quietly went about recovering from an estimated $300 million worth of damage.

Hugo landed a number of body blows, and officials say as many half of all the trees in the county had been toppled by the hurricane's relentless winds.

Spokesman Gary LeCroy confirmed six deaths in the county, including two residents who apparently drowned in the Wando River.

"We got hit as bad as anyone in the state," said LeCroy, public information officer for for the county's disaster preparedness agency. "The damage is very widespread, very extensive."

Saturday, officials at the disaster preparedness agency's headquarters tried to devise plans for a difficult next several weeks. The realities are no water, no power and minimal communications inside and outside the county.

"Our problem is we've had a terrible time getting information to the public," said LeCroy. "We have a 7-to-7 curfew and a lot of trouble getting the word out."

Don Wohlfeil of the Lower Counties Emergency Operation's Center said most relief agencies were working with power from gasoline generators. In the county, he said, he knew of only one gas station that was open.

"We've had virtually no contact with anybody," Wohlfeil said.

Officials estimated that Berkeley County would not have power restored for two to four weeks.

Calhoun County

The storm zapped power to all of Calhoun County and downed power poles and trees. There were no fatalities, said Bill Cartwright, chief deputy with the Sheriff's Department.

Houses suffered extensive damage, including several struck by falling trees, Cartwright said. Mobile homes sustained the most damage.

"In plain and simple terms, it's much worse than we expected," said Robert Randolph, an announcer for WQKI radio in St. Matthews. "The power company and just everyday people are out with their chain saws trying to clear off roads.

"A few businesses had there windows broken. Trees have fallen all over the place, over cars, over houses. Power lines are down everywhere."

Clarendon County

Clarendon County remained without water and only spotty power service Saturday. Virtually every road in the county was blocked by fallen trees, said Emilee Hemingway, emergency preparedness director.

"It would be easier to look at the one or two buildings left and tell you what wasn't damaged," she said.

About 85 percent of the structures in the county received damage, 40 percent were destroyed, she said.

Three fire stations, the county courthouse, the police station and a National Guard Armory received damage.

A few grocery stores began opening Saturday, and county officials were seeking generators and tanks of water from any source. None had arrived Saturday.

Darlington County

On Saturday, 40 percent of Darlington County, which is served by Carolina Power & Light, had power restored. It may be Wednesday or Thursday before power is restored to the rest of the county.

Darlington County Administrator Jim Schaefer said 824 people were in county shelters Thursday night. By Friday night, the shelters were empty and closed down.

In Lamar, officials said the town has no water.

Major damage was reported to mobile homes across the county, but there was little serious damage to permanent structures.

There were no deaths and three known injuries – none severe.

Florence County

No major injuries were reported in Florence, but officials estimate that the storm caused millions of dollars in property damage.

Downtown Florence was littered with shingles, awnings, aluminum siding, destroyed plastic signs and fallen trees.

Florence Police Lt. Robert Ross said Saturday that about 30 percent of the city was without power, but that the city's shelters had been cleared out. Friday, about 1,500 people were in the shelters.

He said that there were no serious problems with the water system and that the area was beginning t get back to normal.

"We've been put to a crawl," he said.

Some radio stations in the Pee Dee and near Florence were asking people to call in if they knew where residents could buy ice.

Damage reports for FLorence County as a whole were not available because the Florence County Emergency Preparedness Center was shut down Saturday afternoon apparently so its employees could get some sleep.

Kershaw County

Camden began overcoming its storm damage Saturday as power in portions of the city was restored, but electricity meant little to residents whose homes had been smashed by trees.

"I won't ever like the smell of pine again," Sharon Ibarra, a Kirkover Hills resident, said as she pointed to a tree in her kitchen.

The Ibarras were among about 40 residents of the Kirkover Hills section in the Kershaw County town who suffered damage to their homes and cars as Hugo virtually deforested the area.

Downtown Camden also was ravaged by the storm, but, by Saturday, most of the shattered storefronts had been boarded and glass swept from sidewalks.

County officials opened the National Guard Armory as a shelter

Saturday, particular for persons with respiratory problems.

"We've still got people who need housing," said Gary Elliott, the county's emergency preparedness director.

County officials also were seeking generators to operate rural water systems, Elliott said.

City Manager Gary Cannon estimated that some residents would be waiting three to five more days for power and that trees and debris in the city's 11 parks might not be cleared completely for a year.

Some portions of the county, including the Black River Road to Lee County, remained impassable without a bulldozer, Cannon said. No monetary estimate of damage has been made, city and county officials said.

Lake Wateree

Dozens of home were damaged around Lake Wateree in Fairfield and Kershaw Counties.

"I've seen sailboats crunched by trees, docks and gazebos gone. It looks like someone blew it up," said Jean Harwell, the broker for Lake Wateree Properties. "I literally cried when I saw it."

She said Lake Road in Kershaw County seemed to be the hardest hit.

The real estate company has been trying to contact homeowners, she said.

"Everybody's got damage. I'm trying to get them and tell that they don't have a roof on their house or that trees are stacked on it," Ms. Harwell said. "We cut our way back in to our house on Goat Hill Road."

She said police set up roadblocks to keep non-residents away.

A generator on the Lake Wateree Dam was damaged early Friday, Sherry Brown, a Duke Power Co. spokeswoman, said.

"There was some minor damage when a window blew in," she said. The generator will be repaired by next week, she said, and does not effect the operation of the dam.

Orangeburg County

The Orangeburg County communities of Eutawville and Holly Hill apparently took some of the hardest hits in the Midlands.

Residents cleaning up the aftermath of Hugo almost unanimously insist that much of the damage was caused by tornados. The evidence would seem to back up those claims.

Thousands of pin oaks and pine trees are either snapped off, uprooted or twisted like licorice. Electricity and water service have been out for more than a day, and prospects don't look good that either will be restored soon.

All but a portion of the Santee area lacked power Saturday, while the entire Santee area was without water. Also lacking power were Bowman and Elloree.

"The National Guard is bringing in generators to help supply water for the affected areas, and the Orangeburg County Chapter of the American Red Cross is delivering emergency and water supplies as well," Smith said.

All of Orangeburg County's primary roads were clear Saturday afternoon, but several secondary roads remained blocked by trees.

Emergency preparedness officials had no damage estimates but said that the most structural damage was found in Eutawville and in Santee, where the roof of a Days Inn was heavily damaged.

Despite significant property damage, Orangeburg County reported only one death as a result of Hurricane Hugo.

Samuel Middleton, 69, of Route 1, outside of Eutawville, died around 1 a.m. Friday when high winds carried his mobile home 40 feet, destroying it and crushing him, said Orangeburg County Coroner Paul Simmons.

Orangeburg EMS Shift Supervisor Thomas Jones thinks county citizens' prompt reaction and attentiveness prevented more deaths.

"Everywhere I went I saw people buying radios and flashlights and watching television," Jones said. "I think our people listened and paid attention and knew what to look for."

Ted Johnson, manager of the city Department of Public Utilities, said he thought 90 percent of the customers in the Orangeburg area would have power by Saturday night.

Johnson denied rumors that Orangeburg's water was contaminated, as had been reported by several radio stations.

Williamsburg County

Kingstree Mayor Jimmy Kirby surveyed the damage to his town Saturday.

"No home are destroyed, but many have tree damage," he said.

"I think it really woke us up," Kirby said. "I am 50 years old, and this is the first bad storm for me, but it goes to show the unity of the people of a small town, neighbors."

Residents prepared for the worst by catching rain water for drinking and cooking, Kirby said, but that did nothing to solve the problem of bathing.

Since the storm, residents have been going down to Gilland Park to bathe in the Black River.

"We really should have sung, "Let's Gather at the River," Kirby said. "I can't imagine what the people in Andrews thought about all the soapy water."

Kirby said the Carolina and Fair Deal warehouses were damaged, as was the Goldkist fertilizer plant, which had a wall blown out by the high winds.

There was damage to the roofs of the City Hall complex and to the Williamsburg County complex, Kirby said.

Shops and restaurants in the town were also damaged.

Trees in e area were devastated by the storm.

Kingstree Town Manager Ken Courtness said most of the downtown area had some sort of damage.

Power in South Carolina

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 4 – 5 & 6 – 8

Focus: The various forms of energy used to produce electricity in South Carolina.

Subject: Science, Social Studies

Materials: Handouts included with this lesson

Teaching Time: One class period, plus student work

Vocabulary: fossil fuels, nuclear reactor, nuclear fission

Electricity-Generating Plants in South Carolina

Learning Objectives

In this lesson students will interpret charts, graphs, and illustrations to discover the story of power in South Carolina. Students will:

- see how electricity is generated and distributed in South Carolina.

Materials

Handouts "Power in South Carolina"
Copies of "The Energy FactBook: A Resource for South Carolina" (Optional: These are available from the S.C. Department of Health and Environmental Control's Resource Center, 1 800 SO USE IT, or the State Energy Office, 1 800 851 8899.)

Background

excerpts from "The Energy FactBook: A Resource for South Carolina"

South Carolina is a growing state. As our economy has developed, so too have our energy needs. In the last several decades, only four states have had higher energy use rates than we in South Carolina have had.

While we use energy in every sector of the economy, industry uses the most. It takes large supplies of energy to run the mills, factories, and farms that make our state prosper. In 1991, industry accounted for 40% of the state's energy use.

The transportation sector is the second largest user of energy, using 27 % of the state's total use. As primarily a rural state, South Carolina is state of drivers. It takes nearly 2 billion gallons of gasoline a year to keep South Carolina moving.

In our homes, we use 20% of the state's energy and the commercial sector uses the other 13%.

South Carolina does not have many natural energy resources of its own. The gasoline and other fossil fuels that make our economy grow must be imported from other states and countries.

Through science and conservation, we are now using proportionately less fossil fuels. In 1990, over one-third of the state's energy needs were met by energy resources other than fossil fuels.

DOWN TO EARTH

The United States Environmental Protection Agency (EPA) estimates that computers account for 5 percent of commercial electricity use. New computer chips that "sleep" when not in use are expected to save 50 to 70 percent of this energy.
source: *1994 Environmental Almanac*

BEST COPY AVAILABLE

Learning Procedure

1. **Ask the class:** When we switch on a light, what is the source of this power? *(Students may say power lines or power plants in general or they may be familiar with a local plant.)*

Ask: How was this power created? (*Review with students the basics of electric power generation. You may use videos, such as Santee Cooper's* PowerHouse Tour *to review the generation process. The illustration,* Producing Electricity, *included with this lesson gives the basics.*)

Ask: What can we tell about the different types of fuel sources that are used to produce electricity? *(They each create heat that is used to create steam that turns the turbine that creates electricity.)*

2. Tell the class that there is a lot that you can learn about power in South Carolina from interpreting charts, graphs and illustrations, just the way they interpreted the basic illustration, *Producing Electricity*.

Give each student or small groups of students a copy of the handouts, *Power in South Carolina*, and have them read the text and interpret the graphics to answer the questions and learn more about power in our state.

Extension Activities

1. Have students research an energy source – coal, oil, natural gas, nuclear, solar power, wind, etc – used in creating energy. Students should be encouraged to find:
    - How was it formed (for fossil fuels) or the process that causes it (solar, etc.)
    - The availability in our state, country, world
    - Environmental advantage/disadvantages.

2. Have students consider a good way to reduce energy use in the state and then write several paragraphs to explain. For example, they may suggest the use of more public transportation to reduce energy used for transportation (petroleum), or ways to lower residential energy use through use of solar heating or other efficient usage practices, or ways factories could save energy.

3. Have students write letters to the utility company that supplies their electricity asking about how power will be supplied in the future.

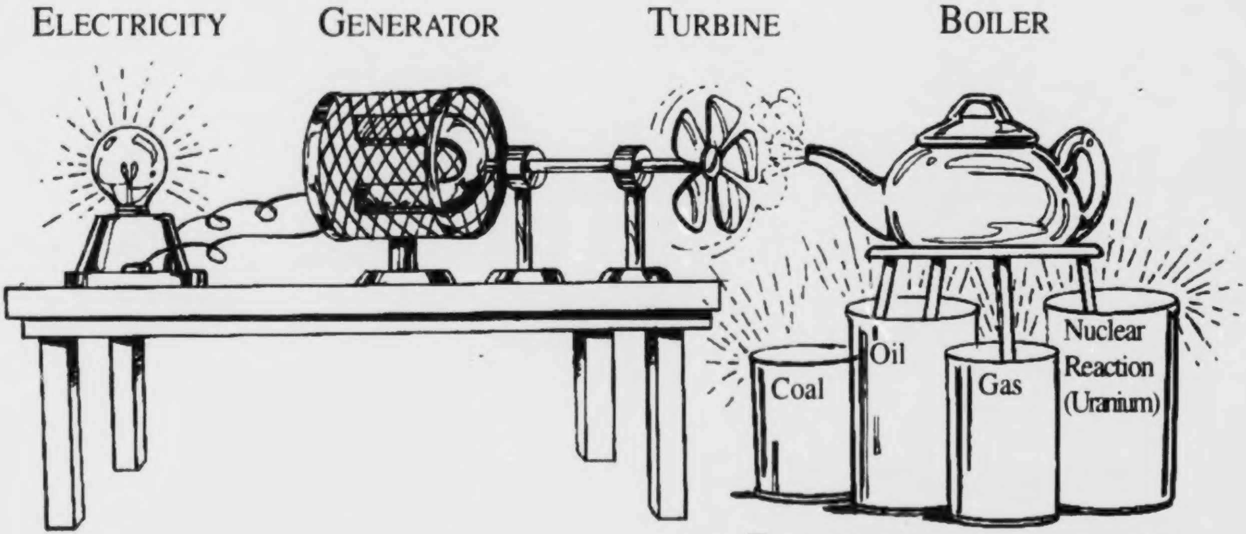
Does your power company have any investments in renewable energy or other alternative energy technology? Why or why not?

4. Plan a field trip to a power generating facility in your area or invite a representative to come to your school.

Just Do It

Use energy wisely at home. Conduct a home energy audit to determine if your home is energy efficient.
Your local power company can help.

Producing Electricity


ELECTRICITY
GENERATOR
TURBINE
BOILER
Coal
Oil
Gas
Nuclear Reaction (Uranium)

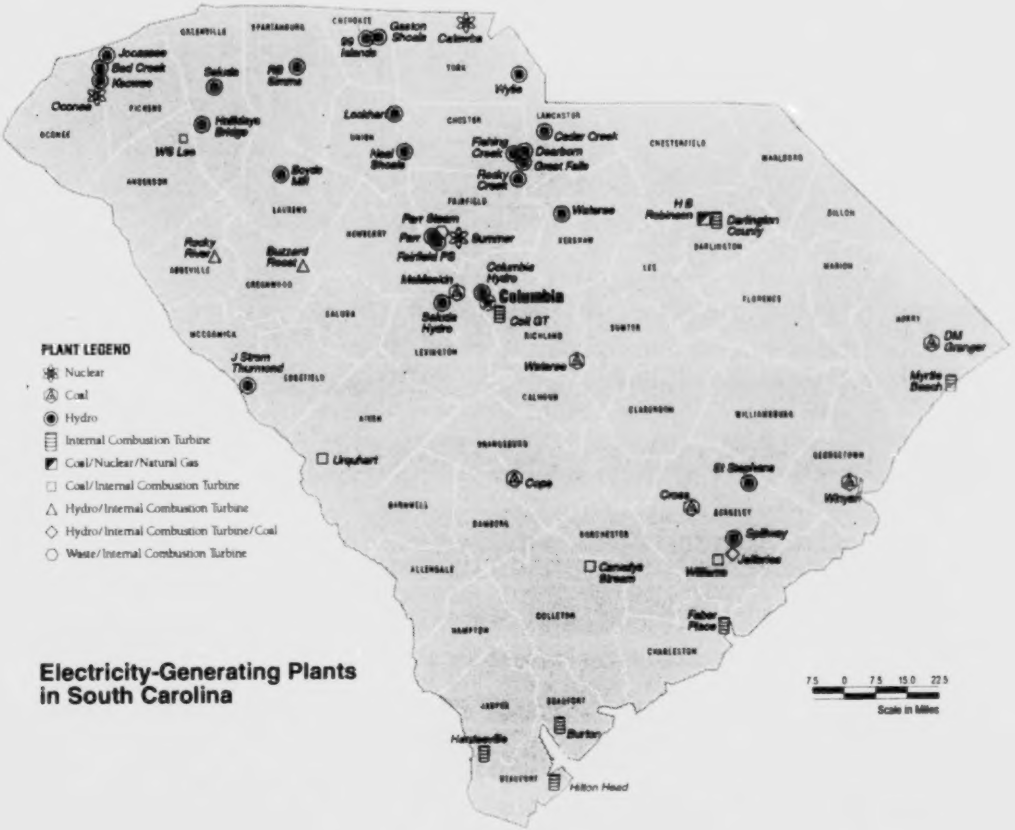
FUEL SOURCES FOR GENERATING ELECTRICITY

PRODUCING ELECTRICITY
Several fuel sources are used in South Carolina's electricity generating plants. Each of these fuel sources provides the heat that is used to create steam. This steam provides the power to turn the turbine that spins the magnet inside the coil, creating electricity. In South Carolina, nuclear fission creates the heat that provides about 60 percent of the electricity.

In hydroelectric facilities, no heat is needed. Falling water is used to spin the turbine.

POWER IN SOUTH CAROLINA

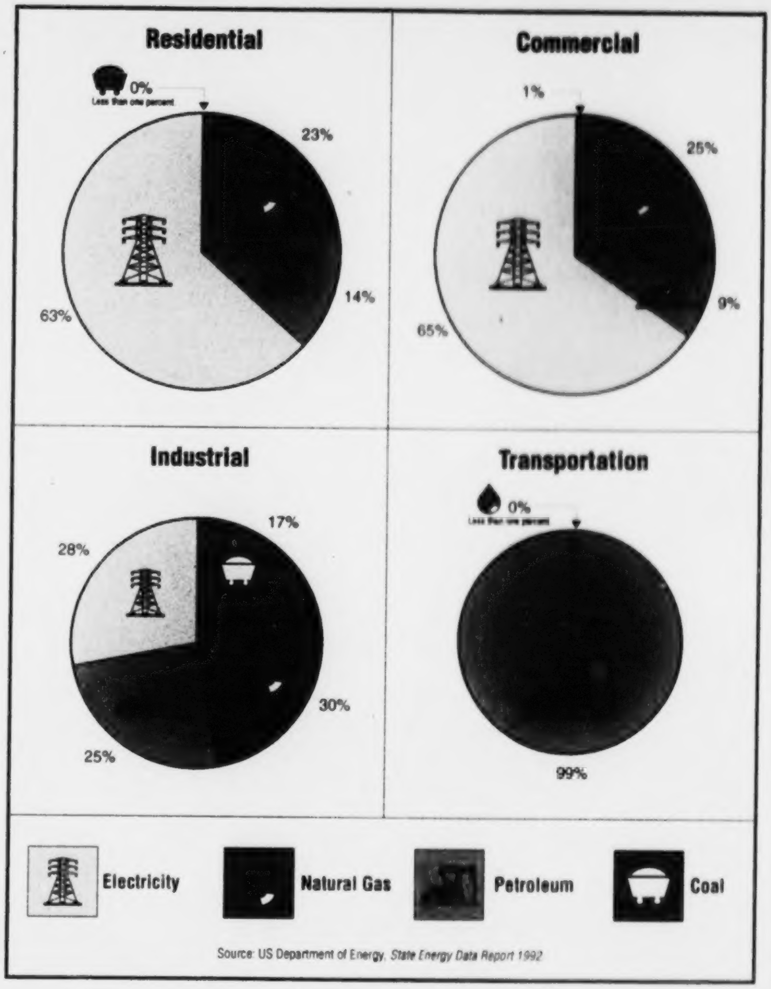
Graphs, charts and illustrations about energy in South Carolina


GREENVILLE
SPARTANBURG
CHEROKEE
Gaston Shoals
99 Islands
Catawba
Jocassee
Bad Creek
Keowee
Oconee
Saluda
RB Simms
YORK
Wylie
PICKENS
OCONEE
Hollidays Bridge
WS Lee
Lockhart
CHESTER
UNION
Neal Shoals
LANCASTER
Cedar Creek
Fishing Creek
Dearborn
Great Falls
Rocky Creek
CHESTERFIELD
MARLBORO
ANDERSON
Boyds Mill
LAURENS
FAIRFIELD
Wateree
H B Robinson
Darlington County
DILLON
Parr Steam
Parr
Summer
Fairfield PS
NEWBERRY
KERSHAW
DARLINGTON
Rocky River
Buzzard Roost
ABBEVILLE
GREENWOOD
McMeekin
Columbia Hydro
Columbia
Saluda Hydro
Coit GT
LEE
MARION
FLORENCE
SALUDA
RICHLAND
SUMTER
HORRY
DM Granger
MCCORMICK
LEXINGTON
J Strom Thurmond
EDGEFIELD
Wateree
Myrtle Beach
PLANT LEGEND
Nuclear
Coal
Hydro
Internal Combustion Turbine
Coal/Nuclear/Natural Gas
Coal/Internal Combustion Turbine
Hydro/Internal Combustion Turbine
Hydro/Internal Combustion Turbine/Coal
Waste/Internal Combustion Turbine
CALHOUN
CLARENDON
WILLIAMSBURG
AIKEN
ORANGEBURG
Urquhart
St Stephens
GEORGETOWN
Cope
Cross
Winyah
BARNWELL
BERKELEY
BAMBERG
DORCHESTER
Spillway
Jefferies
Williams
Canadys Steam
ALLENDALE
COLLETON
Faber Place
HAMPTON
CHARLESTON
7.5 0 7.5 15.0 22.5
Scale in Miles
JASPER
BEAUFORT
Burton
Hardeeville
BEAUFORT
Hilton Head

Electricity-Generating Plants in South Carolina

STUDENT HANDOUT

South Carolina's
net energy consumption
by sector – 1992



Source: US Department of Energy, *State Energy Data Report 1992*

Use the charts above to answer these questions about energy in South Carolina.

1. What are the sectors or categories of energy consumers in South Carolina?

____

2. What are the four types of energy resources listed on the charts?

____

3. Which sector uses the largest percentage of petroleum? ____________________

Why would this sector use so much petroleum? ____________________

4. Which sector uses the largest percentage of natural gas? ____________________

STUDENT HANDOUT

Getting to know electricity in South Carolina

Use the information on the following pages of the *Energy FactBook* to answer these

1. How many power plants are there in South Carolina? ______________________________

2. How many nuclear plants are there in South Carolina? ___________________________

2. What percentage of South Carolina's electricity is generated by nuclear power? _______________

3. How many exclusively hydro plants are there in the state? _______________

4. What percentage of the state's power comes from plants fueled by petroleum, natural gas or water?

____

5. What investor-owned company provides the most power to the people in this state? ____________

6. Draw and label a pie chart that shows how electricity is generated by SCE&G.

7. What is South Carolina's public utility company?_______________

8. How many people are served by this public-owned utility? ___________

9. What percentage of electricity generated in the state is used by private homes? _______________

10. What are "electric cities" in South Carolina? ___________________________________

STUDENT HANDOUT

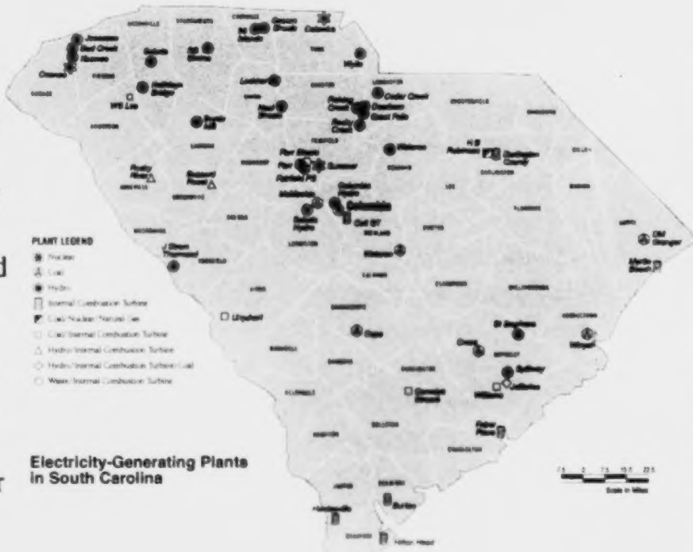
Electricity In South Carolina

reprinted with permission from the *Energy FactBook*

South Carolina's use of electricity continues to increase. In the past twenty years, the state has more than tripled the amount of electricity produced.

As the state's economy has grown, so has its need for electricity. As the map shows, the state has 59 power plants.

In 1991, these plants generated almost 80 billion kilowatt-hours of electricity **Nearly two-thirds of this electricity came from nuclear power plants.** Coal-fired plants produced almost all of the remaining electricity Less than 5% of our electricity comes from plants fueled by petroleum, natural gas or water.


PLANT LEGEND
Nuclear
Coal
Hydro
Internal Combustion Turbine
Coal/Nuclear/Natural Gas
Coal/Internal Combustion Turbine
Hydro/Internal Combustion Turbine
Hydro/Internal Combustion Turbine/Coal
Water/Internal Combustion Turbine

Electricity-Generating Plants in South Carolina

SOUTH CAROLINA'S UTILITIES

South Carolina is served by investor-owned and municipally-owned utilities as well as rural electric cooperatives.

THE INVESTOR-OWNED UTILITIES

Four investor-owned utilities serve South Carolina: South Carolina Electric & Gas (SCE&G), Duke Power Company, Carolina Power & Light (CP&L), and Lockhart Power. These utilities have an assigned service territory, an obligation to serve, and are regulated by state commissions and federal regulations. Each is owned by millions of small investors who have stock in the company.

With nearly half a million customers (447,000 in 1991), SCE&G is the primary supplier of electricity in our state. It maintains 17,000 miles of transmission lines and 3,000 miles of distribution lines. Of the electricity generated by this utility, 66% comes from coal, 25% from nuclear fuel, and 9% from water power, internal combustion or other sources.

Duke Power Company, headquartered in Charlotte, NC, serves nearly 340,000 customers in South Carolina's Upstate region. Duke also operates more than 2,000 substations and switching stations interconnecting some 13,000 miles of transmission lines and 67,000 miles of distribution lines.

Over 60% of the electricity produced by Duke Power comes from nuclear fuel. Thirty-seven percent of the electricity is generated by coal and 3% comes from water power, internal combustion or other sources.

Carolina Power & Light, also headquartered in North Carolina, operates two plants in our state, both in Hartsville. CP&L's service area covers one-fourth of South Carolina, in the Pee Dee region. Of the electricity generated by CP&L, 47% comes from nuclear fuel, 40% from internal combustion or turbine, and 12% from coal.

Lockhart Power is the smallest of the investor-owned utilities in our state. It serves just over 5,000 customers, primarily in Union County. All of the electricity generated by this utility comes from hydropower.

SANTEE COOPER: SOUTH CAROLINA'S PUBLIC UTILITY

The South Carolina Public Service Authority, known as Santee Cooper, is the state's public utility. It was created in the 1930's to bring electricity to rural areas.

BEST COPY AVAILABLE

When it started, less than 3% of South Carolina's farms had electricity. One decade later, Santee Cooper was bringing electricity to 91% of the farms in the state.

In 1990, Santee Cooper produced some 13.6 billion kilowatt-hours of electricity for its one million customers. This makes Santee Cooper the fourth largest public power system in the country.

THE ELECTRIC COOPERATIVES

Much of Santee Cooper's electricity is distributed by rural electric cooperatives. These cooperatives are customer-owned, nonprofit utilities. Their mission is to bring electricity to remote areas at the lowest possible cost.

Today, cooperatives reach nearly one-third of the citizens of our state in both rural and urban areas. To reach customers in rural areas, the cooperatives have to use a lot of power lines. In fact, over 53,000 miles of wire are used to bring electricity to South Carolina's rural citizens.

SOUTH CAROLINA'S ELECTRIC CITIES

South Carolina also has 21 municipal electric utilities. These 21 "electric cities" provide electricity as a public service. Local governments purchase electricity at wholesale prices and then distribute the power to their customers at retail rates. The distribution system is owned by the city.

The municipal electric utilities are financed by bonds. Bonds are certificates of debt which are issued by the municipal government guaranteeing payment of the original investment plus interest by a specified future date.

HOW WE USE ELECTRICITY

The industrial sector uses most of the electricity produced in South Carolina. Almost half of the electricity generated goes to operate factories and mills. Most of South Carolina's industrial users of electricity are concentrated in the Piedmont counties of Greenville, Spartanburg and Anderson.

Nearly one-third of the energy produced in the state is used in private homes. Everything from the basic (refrigerators) to the frivolous (ice cream makers) runs on electricity.

A little over one-fifth of South Carolina's electric energy goes to commercial customers. Again, the biggest users are in Greenville and Spartanburg counties. Charleston County is one of the biggest users of both commercial and residential electricity.

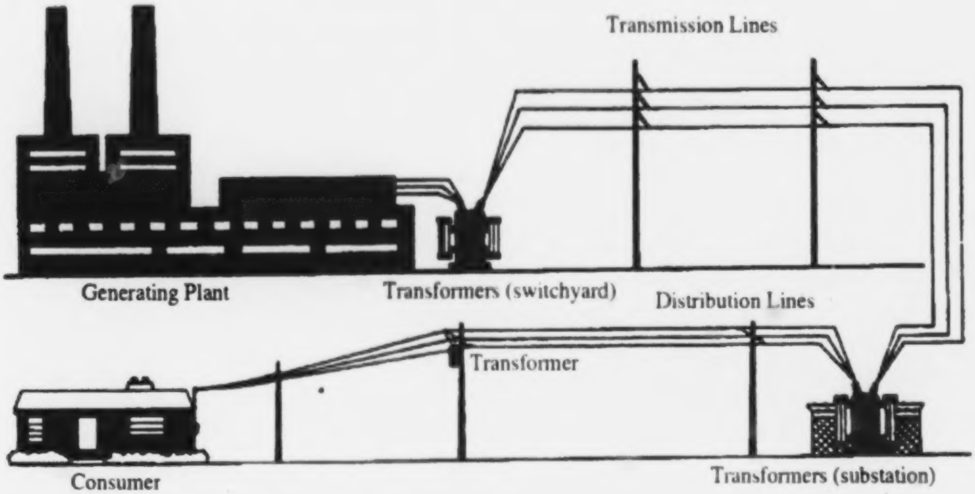
CONCLUSION

Electricity is an important part of South Carolina's energy past, present and future. Its utilities provide electricity to even the most rural areas. Modern technologies including the use of nuclear fuel and pumped-storage allow us to produce energy to meet the needs of all sectors Of the South Carolina economy.

STUDENT HANDOUT

How Electric Energy is Transformed, Transmitted and Distributed

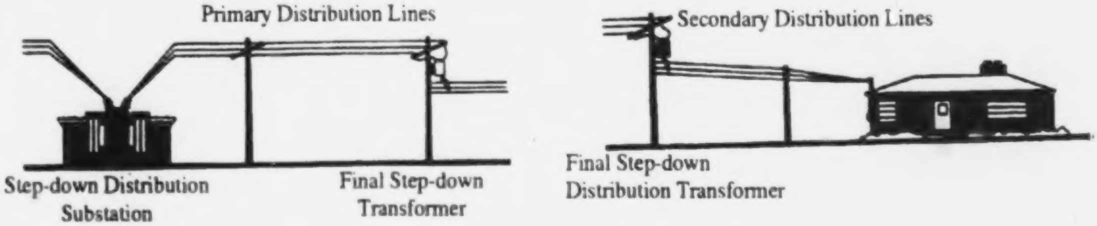
Use these illustrations to answer the question below.


Transmission Lines
Generating Plant
Transformers (switchyard)
Distribution Lines
Transformer
Consumer
Transformers (substation)

South Carolina's power plants generated almost 80 billion kilowatt-hours of electricity in 1991. Power companies in the state maintain more than 150,000 miles of transmission and distribution lines.

Electricity, as it comes from a turbine generator, cannot be sent directly to your house. This is because electricity flows through a wire much like water flowing through a garden hose. Unless there is pressure pushing the water through the hose, it will not comes out the other end. To get electricity through the wires to your home, it must be pushed under pressure. Voltage is the term that describes this pressure. Outside the power plant, **the switchyard has transformers that increase the voltage**. This increase in **voltage** gives the power the push it needs so that it can travel the long distances to reach homes and factories many miles away. The wires that carry this high voltage are called **transmission lines**.

When the electricity gets to your neighborhood, its voltage is too high to use in homes and factories. **At a substation, transformers reduce the voltage**. The electricity leaves the substation along wires called distribution lines. These are the lines along the streets in neighborhoods. Before the electricity comes into your house, the voltage is reduced one more time by a pole transformer.


Primary Distribution Lines
Step-down Distribution Substation
Final Step-down Transformer
Secondary Distribution Lines
Final Step-down Distribution Transformer

True/False

T F 1. Transformers are used to *increase* and *decrease* the voltage of electricity as it is sent from a power plant to your home.

T F 2. At substations the voltage of electricity is changed.

T F 3. Voltage is increased when power moves from transmission lines to distribution lines.

Power In South Carolina

Use the charts, graphs, and illustrations in your handout to answer these questions about Power in South Carolina.

CIRCLE THE ANSWER

1. South Carolina depends on fossil fuels from
   (a) coal mines in South Carolina (b) mines in other states (c) nuclear power plants.
2. Residents use
   (a) 20% of the state's energy (b) 50% of the state's energy (c) 70% of the state's energy.
3. Fossil fuels make up
   (a) two-thirds of the state's energy (b) one-third of the state's energy (c) half of the state's energy.
4. The Foster Wheeler plant generates power from
   (a) nuclear fission (b) coal (c) municipal waste.

TRUE OR FALSE

5. _____ The residential sector in South Carolina uses more natural gas than electricity.
6. _____ The commercial sector in South Carolina uses more electricity than the residential sector..
7. _____ There are more hydroelectric plants in South Carolina than nuclear plants.
8. _____ The transportation sector is the single largest user of petroleum products.
9. _____ Transformers are used in various places in distributing power from the generation station to the consumer.

CHECK THE BOXES THAT CORRECTLY ANSWER THE QUESTIONS. YOU MANY CHECK MORE THAN ONE FOR EACH.

10. The fuel source for generating heat in the production of electricity can be

_____ Coal _____ Nuclear fission _____ Natural gas _______ Oil.

11. Check the kinds of problems caused by burning oil and coal.

_____ Air pollution _____ Water pollution

_____ Land destruction _____ Waste products

_____ Noise pollution

12. Match the fossil fuel with its most important use:

_____ coal a. generation of electricity

_____ petroleum b. heating houses and stores

_____ natural gas c. transportation

Action
for a
cleaner tomorrow

TABLE OF CONTENTS
GRADES 6 – 8

Title	Discipline	Focus	Page
Trash Can Scan	Science, Math, Art	Solid Waste	1
Population & Garbage	Math, Science	Effects of Population Growth on Garbage	5
Death of a Lake	Science	Waste & Water	9
Bikes & By-products	Social Studies, Science	Manufacturing By-Products	15
Hazardous Waste In My Town	Social Studies, Geography, Economics	Hazardous Waste	19
Signs of the Times	Language Arts, Social Studies	Hazardous Awareness & Identification	27
Making Hazardous Waste Decisions	English, Drama, Social Studies	Where Waste Goes	35
A Trip to the Landfill	Social Studies, Science	Disposal in Landfills	47
Tin Can Incinerator	Science, Math	Incineration & Reduction	51
Investigating Incinerator	Science, Social Studies, Language Arts	Waste Incineration	55
When They're Gone, They're Gone	Social Studies, Science	Natural Resources	61
Fast Food Survey	Science, Social Studies, Math English	Excessive Packaging	65
Oil & Water	Science, Social Studies	Oil Pollutes Water	69
Where Did … Problem Come From?	Social Studies	Packaging Waste	73
Environmental Shopping	Home Economics, Social Studies, Math	How to Buy Less Waste	75
Glass Making	Science, Art, Social Studies	Glass Recycling	81
Paper Making & By-Products	Science, Social Studies, Art	Paper Recycling	85
Life Cycles	Language Arts, Social Studies, Science	Recycling, Reuse	89
Recycling: It's An Energy Issue	Science, Math	Economics of Recycling	91
Bottom Line of Recycling	Social Studies, Economics	Recycling	97
Lawn Lasagna	Science, Biology, Horticulture, Vocational Agriculture	Composting	99
Help Wanted	Social Studies, Language Arts	Environmental Occupations	103
Ins & Outs of a Worm's Life	Science	Composting	107

I'm Melting	Math, Geology, Science	Acid Rain	113
Ozone or the No-Zone	Math, Health, Science	Ozone	117
Feeling Alright?	Geology, Health, Science	Air Pollution & Health	121
Living in the Greenhouse	Math, Health, Science	Greenhouse Effect	123
Erosion	Science	Soil Erosion	125
Runaway Water	Geology, Science	Watersheds	129
The Water Table	Science	Water Table	135
Water Filters	Science, Health	Water Quality	139
Take Me to Your Meter	Math, Science	Water Conservation	141
Saltwater & Sink Holes	Science, Geology, Hydrology	Water Conservation	147
S.C.'s Bodies of Water	Geology, Science Social Studies, Language Arts	S.C. Water Bodies	149
Power in South Carolina	Social Studies, Science	Electricity in S.C.	153
Energy from the Sun	Math, Science	Solar Energy	163

Trash Can Scan

Preparation Time: **Easy-To-Do** Moderate Extensive

Grade: 6 – 8
Focus: Solid waste components
Subject: Science, Math, Art
Materials: See list below
Teaching Time: One hour a day for 3 or 4 days
Vocabulary: Weight vs. volume, components, waste stream

Learning Objective

Students will:

- explore what garbage consists of and that it can vary in composition over time or by location of collection
- classify, weigh, and graph the composition of the classroom's trash
- examine the concepts of volume and weight and how different types of trash affect the quantity of solid waste produced.

Background

The **waste stream** is comprised of many different kinds of objects. Composition of trash by **volume** and **weight** can be very different. In South Carolina, the solid waste stream, measured by weight, is made up of:

- 37.6% paper
- 15.9% yard waste
- 6.6% glass
- 6.7% food
- 9.3% plastic
- 8.3% metals
- 15.6% other (includes miscellaneous wastes that cannot be categorized elsewhere such as clothing or wood).

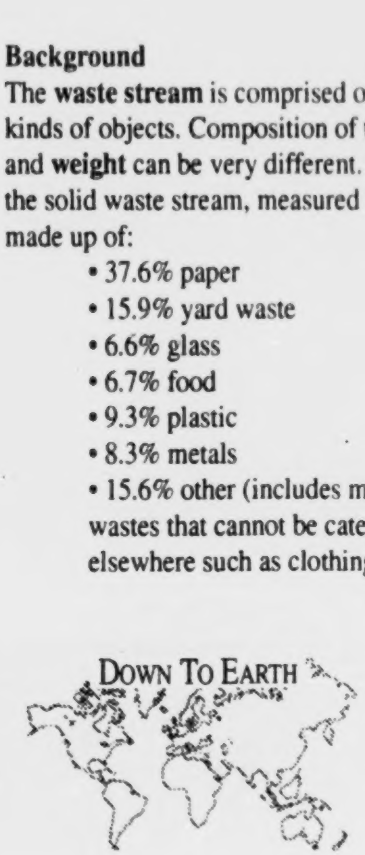
Materials

Updated chart from the South Carolina Solid Waste Management Plan (included with this lesson), three days worth of classroom trash, gloves, scale capable of weighing in ounces or grams, old newspaper, construction paper, and/or graph paper.

Learning Procedure

1. **Ask:** What kinds of things do you throw away? What are these things made of? What materials do you think makes up most garbage?

2. Distribute the South Carolina Solid Waste Management Plan handout. Discuss the different categories of trash *(paper, plastic, metal, etc.)*, and list examples of items in each category. Divide the students into seven teams, each representing one of the seven categories of trash. Have each team create trash category posters or collages using these lists



Germany, Japan, Sweden, Canada and Norway have introduced their own environmental seals. These seals indicate products that meet government standards for not harming the environment.

and drawings or pictures from magazines and newspapers. Encourage students to make their posters 3-dimensional by using the actual items.

3. Collect all trash discarded by the class for several days. For sanitary reasons, exclude food but retain wrappers. Lay old newspaper on the floor, dump the trash on it, and let the students sort the trash according to category, i.e., paper, plastic, metal. For items that can fit into more than one category, have them decide which one is predominant. If many items are equally mixed, you might want to create a mixed materials, or "Other" category. Working in groups, have the students weigh each category of trash and record their results on the board.

4. Have the students create a bar graph bulletin board display that compares the various **components** of the classroom waste stream. Each material can be represented by a different colored construction paper bar or to make the board 3-dimensional, use crushed pieces of the actual material. For example, crush aluminum cans and stack them up to represent the quantity of aluminum in the classroom waste stream. Determine the scale to be used (e.g., two vertical inches equals one ounce, etc.).

5. Repeat this activity for three separate trials, each time separating and weighing the trash, recording the data, and constructing a bar chart. Students may also calculate the three-trial average. Have the class graph the results.

6. Compare your classroom results to the figures on the handout. What are the differences and similarities? Did the time of week when the trash was collected affect the results? Why? Would the time of year or season affect the results?

7. Ask the students if all the items they throw away are the same size and weight. Have them name some examples that are small, large (bulky), light, heavy, etc. Ask the students to predict which materials make up the greatest portion of waste by volume, by weight, and by number of items.

A. Using the trash collected in the classroom for a week or a sample trash can of items prepared in advance, have the students separate it into the different categories of materials — glass, plastic, paper, metal, etc.

B. Ask the students which category do they think is the heaviest? Which takes up the most room? Which contains the greatest number of pieces? Have the students write down their answers in order of heaviest to lightest, bulkiest to most compact, and most to least numerous.

C. Weigh each category of items. For the paper category, material could be divided into newspaper, cardboard, writing paper, and other. Then place the objects in a clear container and determine their volume by measuring how much space they occupy (width, depth, and height). Count the number of items. Make a chart on the board showing the weight, volume, and number of pieces of each category. Make a bulletin board display using different colored blocks to represent each part of the waste stream. Make one trash can showing the trash content by weight, another showing trash content by volume, and a third showing trash content by number of items. For each category of waste, cut out a band of paper representing its percentage of the total, so that when stacked one above the other, the three trash cans are full. What are the implications of these differences in terms of waste disposal?

D. Discuss how weight and volume of trash are both important in its disposal. *(Bulky items may not weigh much, but may take up more space in the landfill or trash compactor. See the Landfill Volumes chart included with this lesson.)* How might the volume change if glass, cans, or boxes are crushed? Does the weight change if the volume changes?

Extension Activities

1. Have the different groups survey trash cans from other areas of the school (other classrooms, the library, the gym) or home, and compare the results with those obtained in your classroom. Does the

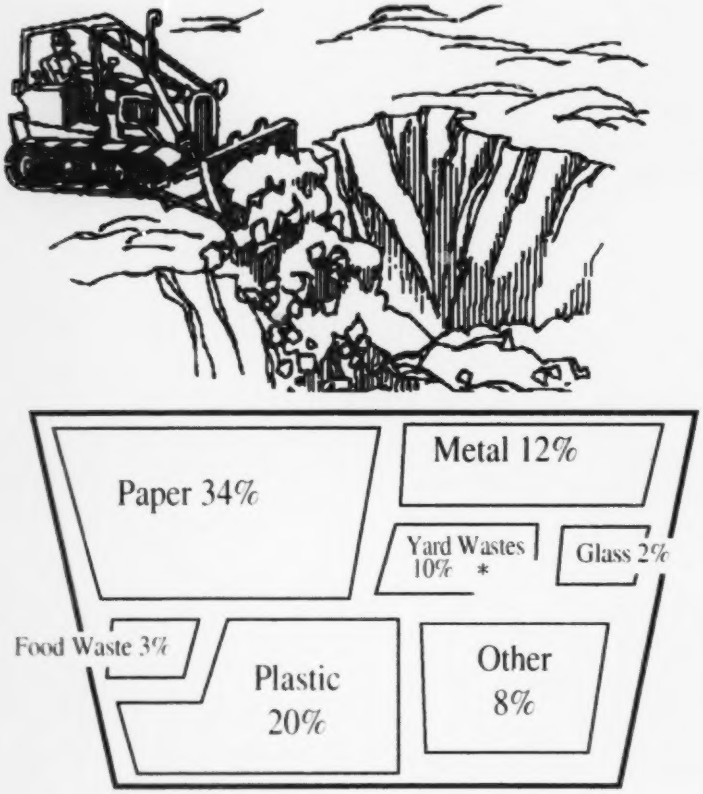
composition of the waste stream vary at each location? If so, why? Discuss differences and similarities of the trash from different locations. Predict the results of this type of trash analysis using the garbage from department stores, supermarkets, factories, and other institutions. What would be some of the differences and similarities in the composition and amount of waste? Why?

2. Extend the exercise by asking what other sorts of items are thrown away that were not represented in the trash can: yard wastes, white goods (refrigerators, washing machines), tires, etc. Where do they fit into the spectrum? Tell the students that these are called "special Wastes" and are banned from South Carolina's landfills. In fact, there is a $2 per item tax on white goods, tires, and lead-acid batteries paid at the time of purchase to help defray the cost of disposing of these special wastes.

Just Do It

Visit or write the local landfill to discover how South Carolina's garbage is measured.

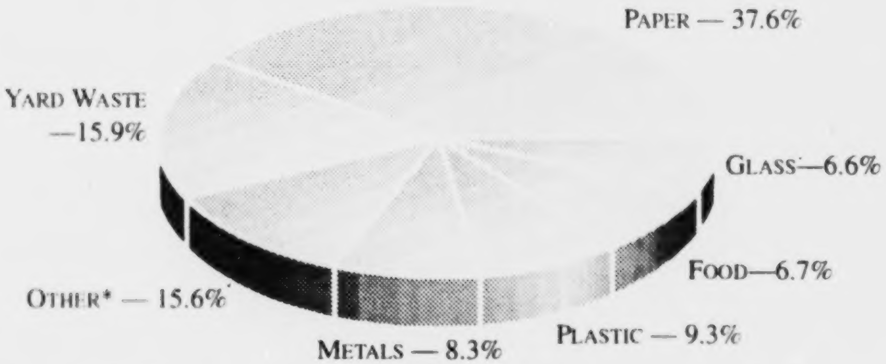
Landfill Volumes



* Note: Yard wastes are now banned from South Carolina landfills.

SOUTH CAROLINA SOLID WASTE STREAM CHARACTERIZATION †

PERCENTAGE BY WEIGHT



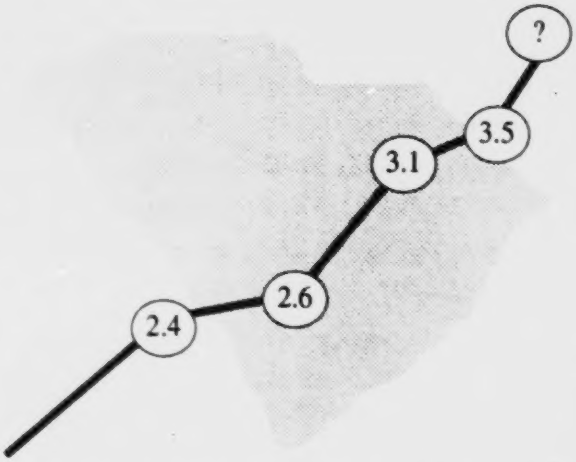
* Other includes miscellaneous wastes that cannot be categorized elsewhere.

† This solid waste stream characterization includes residential, commercial, industrial, agricultural, governmental, and all other solid wastes that are disposed in municipal solid waste landfills.

Population & Garbage

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 6 – 8
Focus: Affects of population growth on garbage
Subject: Math, Science
Materials: Student worksheet, graph paper, colored pencils or pens
Teaching Time: Two class periods
Vocabulary: Per capita, growth rate



Learning Objective

Students will:

- describe population growth
- describe growth in the amount of solid waste per person as factors that influence the amount of solid waste generated in South Carolina.

Background

South Carolina's population is 3.6 million and it is expected to reach 4.5 million by the year 2010. (To illustrate 3.6 million people, note that the football stadium at the University of South Carolina holds 70,000 people. You would need more than 51 of these stadiums to hold the entire population of South Carolina.)

This population **growth rate** means more jobs and a growing economy. It also means more water pollution from sewage and industries, more air pollution from cars and more solid waste. More and more people find South Carolina an attractive place to live, but each South Carolinian is producing more household waste and requiring more consumer goods which results in increasing industrial wastes from manufacturing. In addition, South Carolina's mountains and beaches are popular tourist attractions bringing millions of people (and their garbage) into the state each year. This increase in waste production **per capita** (or per person) is increasing faster than the population. It is the combination of more people and more waste that is causing the garbage glut in South Carolina.

Learning Procedure

1. Copy the chart *Population & Garbage: South Carolina's Trend* onto the board or make a transparency of the chart included with the lesson. Use either standard or metric measurements.

2. Ask students to describe the numbers in the table. What do they show?

3. Tell students that, using the information from this chart, they are going to graph and predict waste trends of the future. Have students set up their graphs with year on the x-axis (horizontal) and the population in millions on the y-axis (vertical). The graph should begin in 1960 and end in 2020. Ask

DOWN TO EARTH

The average resident of India has less than one-tenth the water for drinking, cooking, washing, and bathing than the average Canadian.

students to prepare a line graph based on the population data from the *Populations & Garbage: South Carolina's Trend* chart that you have written on the board. Then, ask students to project the population data to 2020.

4. Use the data on solid waste production per capita from the *Populations & Garbage: South Carolina's Trend* chart that you have written on the board to make a second graph on the same sheet of graph paper. (Use a different color marker to make it easy to read.) Help students modify the y-axis so it records solid waste data in pounds per person per day. Ask students to extend the data to 2020.

5. Based on the data in the graphs, have students answer the following questions (see attached worksheet):

- According to your graph, which is growing faster, South Carolina's population or the amount of waste that is produced per person?

- Calculate the average growth rate for South Carolina's population per year between 1980 and 1990. Calculate the growth rate for waste production per person per year for the same decade.

- If each South Carolinian produces 5.6 pounds (2.52 kg) of solid waste per day, how much will be produced by 3.5 million people in a day? In a year? (NOTE: the 5.6 pounds [2.52 kg] of solid waste generated by each South Carolinian is household waste only. Including industrial waste raises the figure to ten pounds of waste per person per day.)

- Assume one week's worth of trash (7 days x 5.6 pounds [2.52 kg]) of solid waste takes up 1 cubic foot (0.028 cubic meters) of landfill space after it is crushed. Solid waste is normally compacted to 750 - 1,000 pounds per cubic yard. (339.75 kg - 453 kg per 0.765 cubic meter) How many cubic feet (meters) of landfill space are required per person per year?

- Assuming a population of 3.6 million people and 39.2 pounds (17.64 kg) of solid waste per person per week (1 cubic foot or 0.028 cubic meters), how many football playing fields would be required to hold all the waste that is produced in one year? Assume the field is filled to a height of 10 feet (3 meters). (Note: Ask your PE teacher to mark off a regulation football field so students can visualize the volume of waste.)

Questions for the Class

1. Write a paragraph that describes the relationship between population growth and the growth of solid waste per person. Evaluate how growth effects landfills and how landfills effect the population.

2. Write a paragraph with your ideas about how South Carolina can balance growth and solid waste.

Extension Activities

1. Compare South Carolina's population growth with growth figures for the United States (or a single state of the students' choosing). What similarities and differences exist?

2. Is South Carolina's population concentrated in just a few areas? Use recent South Carolina population figures and an outline map of the state to identify the largest concentrations of people. Where would you expect to find the most garbage? (See the South Carolina Solid Waste Management Plan's chapter on the Future of Solid Waste in South Carolina. Check your local library or contact DHEC at 1-800-76 USE-IT.)

3. Find out how the population in your town and county is projected to change over the next five years, 10 years, and 20 years. Who makes these projections and how do they make them? *(Contact your town and/or county planning commission, the South Carolina Department of Commerce, or refer to the South Carolina Solid Waste Management Plan, 1991.)*

Just Do It

We can control how much waste we produce. Develop a plan to reduce the amount of waste your family produces and then put that plan to work.

Population & Garbage: South Carolina's Trend

YEAR	POPULATION (in millions)	WASTE (in lbs./person/day*)
1960	2.4	2.66 (1.18 kg)
1970	2.6	3.27 (1.48 kg)
1980	3.1	3.61 (1.64 kg)
1990	3.6	5.6 (2.52 kg)
1995		
2000		
2010	4.5	
2020		

(* Includes each person's portion of all
household waste generated in the state.
Does not include industrial waste.)

Name:________________________

South Carolina Population & Garbage

After you have completed your graph, answer the following questions (show your work):

1. According to your graph, which is growing faster, South Carolina's population or the amount of waste that is produced per person?

2. a) Calculate the average growth rate for South Carolina's population per year between 1980 and 1990.
   b) Calculate the growth rate for waste production per person per year for the same decade.

3. If each South Carolinian produces 5.6 pounds (2.52 kg) of solid waste per day, how much will be produced by 3.6 million people in a day? In a year?

4. Assume 5.6 pounds (2.52 kg) of solid waste takes up 0.5 cubic feet (0.014 cubic meters) of landfill space after it is crushed. How many cubic feet (meters) of landfill space are required per person per year?

5. Assuming a population of 3.6 million people and 5.6 pounds (2.52 kg) of solid waste per person per day (0.5 cubic feet or 0.014 cubic meters), how many football playing fields would be required to hold all the waste that is produced in one year? Assume the field is filled to a height of 10 feet (3 meters).

Death of a Lake

Preparation Time: Easy-To-Do Moderate **Extensive**

Grade: 6 - 8
Focus: Waste and water
Subject: Science
Materials: Water test kit (available at aquarium supply stores or biological supply catalogs, can also use pHydrion paper or pH meter to measure pH), a box for each student or group of students, handout sheets included in this lesson
Teaching Time: 3 class periods plus homework assignments
Vocabulary: Acidity, alkalinity, acid rain, fossil fuels, organic, pH

Learning Objective

Students will:

- identify the pH level at which various members of an aquatic system are affected and eventually die
- describe the changes caused by increasing acidity in the ecosystem of a lake.

Background

While there are many factors that contribute to the health of a body of water such as temperature and oxygen levels, this lesson will concentrate on the effects of changes in the **pH** of water. The pH level is a common measure of **acidity**. The pH scale ranges from 0 to 14. A value of 7 represents a solution that is neutral. Values greater than 7 indicate **alkalinity**; values less than 7 indicate **acidity**. In South Carolina, the Department of Health and Environmental Control has established a standard healthy pH range between 6 and 9 for surface water.

Even after several years of heavy rains, a lake's natural buffers keep it somewhat alkaline. However, the sudden flush of acid runoff from melting snow and ice, or repeated doses of **acid rain**, can markedly lower a lake's pH level.

Changes in pH may change the populations and/or distributions of the water's inhabitants, putting stress on competing organisms. As the pH level of a lake goes down, the diversity of aquatic life is reduced. (Note: Many South Carolina waters, such as blackwater rivers like the Edisto and Ashepoo, have naturally occurring low pH due to high levels of tannic acids from trees and plants. These waters sustain plant and fish life that have adapted to low pH environments.)

DOWN TO EARTH

While the United States has changed its practices in building dams that pose environmental dangers, little has changed in many other countries. Some of the largest potentially environmentally damaging water projects are now planned in Canada, Mexico, China, Chile, and Vietnam. Each of these projects is driven by one imperative: to produce more electric power to raise the national standard of living to a level comparable to that of nations like the United States that already have their dams in place.

Source: 1993 Environmental Almanac

Major sources of acid precipitation are sulfur oxides and nitrogen oxides. Sulfur oxides are produced by the burning of **fossil fuels**, mostly coal. Nitrogen oxides are from automobile emissions. Although air pollutants seem to be a different issue, air emissions are a contributor to water pollution.

According to the U.S. EPA's *National Water Quality Inventory: 1990 Report to Congress*, South Carolina has 3,594 river miles (5,784 km) that have been evaluated to determine if they meet the criteria for safe fishing. Of these, 3,230 miles (5,198 km) were found "fishable." The state has also evaluated 3,438 miles (5,533 km) to determine if they meet the criteria for safe swimming; and of those 2,010 miles (3,235 km) were deemed safe for swimming.

Learning Procedure

1. Have the students bring water samples from local ponds or lakes to class. Remind them to include the following information with their specimens: location where the sample was taken, human activity on or in the water, human activity near the water (homes, farms, industry, business). Make sure the containers for collecting the water are clean, have no detergent residues and it might be safer it they only use plastic containers.

- Use a water test kit (or other method) to find the pH level of the samples. Based on the water test results, have the students describe the health of the water in terms of its pH level. What life might they expect the water to support, and what would they not expect it to support?

- If any of the examples have a pH level below 7.0, examine the information about the location of the sample sources and the human activity on, in, and near the water. Can the students think of possible explanations for the results of the pH tests? What are the implications for their community? What could be done about acid pollution in our lakes and streams.

2. Give each student or have students bring to class a box decorated to look like a lake. Have them name their lake. (Option: use a single piece of blue construction paper.) Tell them this represents a healthy lake with a pH level of 8 ... slightly alkaline.

- Make copies of the teacher sheet *Flora and Fauna*, included. Cut them into cards. In each "lake" (box/construction paper), place the cards representing various inhabitants of the lake. Each lake could have a set of cards slightly different from the other lakes.

- Give each student a copy of the student sheet *Lakes*, included. Direct the student to change their lakes as the pH drops. Read aloud each pH level, the flora and fauna affected, and the lake conditions. With each item you read aloud, have the students remove the appropriate cards from their lakes. With each drop in pH level, discuss the damages done to the lake. Compare the results to the healthy lake.

Questions for the Class

1. What is the pH level of a healthy pond or lake? Compare and contrast the flora and fauna of a healthy lake with those of a lake that has a pH level of 4.5 or lower.

2. Why should we be concerned about the pH levels of ponds and lakes?

Extension Activities

1. Have students illustrate the various stages of the Death of a Lake. Have them research the lake's inhabitants and prepare short descriptions to go with the illustrations.

2. Pick a local lake or river and research the flora and fauna found there.

3. Research other sources of water pollution such as industrial sources and municipal sewerage. Investigate the role of municipal waste water treatment plants in cleaning sewerage before it is discharged into rivers.

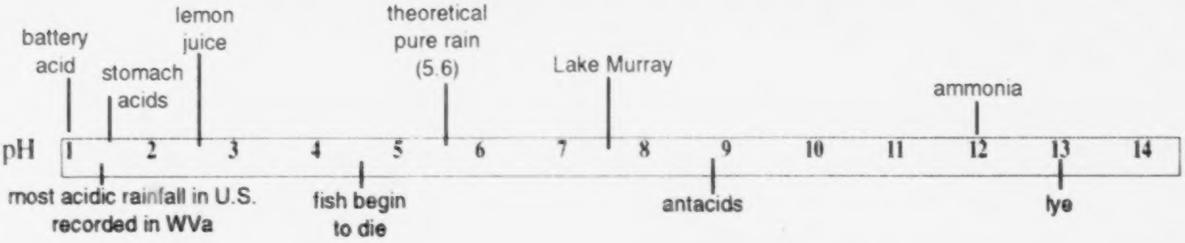
4. Can a lake or river ever become too alkaline? How does this happen and what will it to to the flora and fauna?

5. Do you think a lake with a low pH level can be restored to a healthy state? How do you think this could happen? *(Yes it can. Have students research the health of the Great Lakes over the past three decades.)*

Just Do It

Research and report on the level of acidity of local lakes, streams, and ponds over six months.

Typical pH Levels


battery acid
stomach acids
lemon juice
theoretical pure rain (5.6)
Lake Murray
ammonia
pH
1
2
3
4
5
6
7
8
9
10
11
12
13
14
most acidic rainfall in U.S. recorded in WVa
fish begin to die
antacids
lye

FLORA & FAUNA

salamander eggs *Species A*	salamander eggs *Species B*	snails	tadpole shrimp	plankton
bacterial decomposers	trout	small-mouth bass	catfish	fauna
aquatic life	bream	suckers	bream	(fish)
frogs	many insects	back swimmers	water boatmen	water striders
sphagnum	algae-fungal growths	(fish)	(fish)	(fish)

LAKES

pH Levels	Inhabitants	Conditions
8.0	All inhabitants	Healthy
7.0		Calcium begins to decline.
	Salamander eggs *Species A*	Fail to hatch in small breeding ponds adjacent to lake, possibly because of the disruption of the delicate nutrient exchange process within the eggs.
6.6	Snails	Begin to die.
6.0	Tadpole shrimp	Cannot be found.
	Salamander eggs *Species B*	Fail to hatch.
6.0 – 5.5	Bacterial decomposers	Begin to die; leaves and other organic debris collect on the lake bottom.
	Plankton	Start to drop out, depleting the base of the food chain.
	Trout & small-mouth bass	The disrupted calcium balance begins to upset the exchange of ions across the gill membranes.
	Catfish	Production of eggs prevented.
5.9	Many fish	Toxic metals (aluminum, mercury, lead, cadmium, beryllium, nickel) are released from lake-bottom sediments or leached from surrounding soils. Aluminum toxicity damages the gills, which produces a protective mucus. Without this protective mucus, gills physically erode, suffocating the fish.
5.5	Aquatic plants	Acidophilic mosses, fungi, and filamentous algae have nearly choked them out.
	Bream, suckers	Mature fish die from lack of food, gill damage, or toxicity; eggs produced cannot survive.

LAKES

(continued)

pH Levels	**Inhabitants**	**Conditions**
5.0	Fauna	Starve because calcium is being used by sphagnum moss, which is usually a land plant but thrives in acidic water.
4.5	All fish, frogs, many insects	Die.
	Backswimmers, water boatmen, water striders	Tolerate acidity; thrive without predators.
	Sphagnum, algae, fungal growths	Form tight mat on the lake bottom and may change the release of some nutrients from the sediments.

The lake is deceptively clear and blue because all microorganisms have been wiped out. Blown-in organic debris (i.e., leaves) falls unscathed to the lake's bottom. Very low rates of bacteria eventually consume all the oxygen under the dense mat of mosses, algae, and fungi. Anaerobic bacteria take over, producing carbon dioxide, methane, and hydrogen sulfide. The entire ecosystem on the lake has been changed.

Bikes & By-products

Preparation Time: Easy-To-Do [✓ **Moderate**] Extensive

Grade: 6 - 8

Focus: Hazardous waste, natural resources, manufacturing by-products

Subject: Social Studies, Science

Materials: Diagram *Bicycle materials, wastes & by-products*, a bicycle

Teaching Time: One class period

Vocabulary: Hazardous waste, by-products, toxic, flammable, combustible, reactive, corrosive

Learning Objective

Students will:

- learn what the term hazardous waste means
- learn some of the hazardous wastes created by the manufacturing of a bicycle
- understand how making many of the things that we *do want* creates things that we *don't want.*

Background

Hazardous waste disposal makes the headlines often in South Carolina because the state has one of the only two hazardous waste landfills in the Southeast, one of just 32 in the nation. This hazardous waste landfill in Sumter County receives about 135,000 tons of toxic waste each year. For more information about hazardous waste, see the Resource Section.

Hazardous wastes are used as fuel for cement kilns in Orangeburg and Dorchester counties. In 1991, 133,000 tons of toxic waste fueled these kilns.

Hazardous waste incinerators in Spartanburg County and York County burn about 43,316 tons of toxic waste. Medical wastes are incinerated also in the state at a facility in Hampton County that burns more than 16,000 tons of waste annually.

The U.S. EPA is responsible for monitoring the handling and disposal of hazardous wastes and regulates and enforces the laws that determine how wastes must be handled. These laws require waste management companies to use the Best Demonstrated Available Technology. Some wastes must be processed and recycled, some must be completely destroyed, and others must be detoxified and disposed. As technology advances the methods of handling and disposing of wastes, so do the EPA regulations.

Learning Procedure

1. **Ask:** How many of you have bicycles? What materials are used to make them? What are the frames made of? How about the tires? Where are the metal and rubber and plastic that go into bicycles made? *(In mills and factories that*

One hundred separate hazardous materials are used to make one bicycle.

Source: Science Applications International Corporation *transform raw materials such as petroleum, bauxite, and iron ore into bicycle components.)*

Ask: What makes your bike special … different from others? How many different colors of bikes do we have? Whose bike is shiny? What is the shiny metal on the bike called? Which natural resources are used in making bikes? *(Iron and petroleum for plastics, synthetic fibers, and synthetic rubber; petroleum distillates for paint and paint solvents; bauxite for aluminum; chrome; coal for coke to smelt the iron ore into steel; and others.)*

Ask: What had to happen to the natural resources before they could be used to build your bike? *(They had to be processed in factories.)* Direct the discussion to the [illegible]t that when materials are processed, by-products and waste are also produced. Some of this waste is harmful if not properly managed.

Ask: What are **by-products**? For example, what by-products are produced when you burn wood and paper in your fireplace at home? Are some of these by-products harmful? What about when you bake a cake? Are there leftover materials? What happens to them?

2. Distribute the handout, *Bicycle materials, wastes & by-products.* Using a bicycle in class, guide students in identifying the bike's component materials. (*Steel, synthetic rubber, plastic, chrome, synthetic fibers, aluminum, paint, etc.)* Referring to the diagram, point out some of the by-products and wastes resulting from the manufacturing of these components.

3. Explain that some of the by-products and wastes from making a bike are hazardous. Discuss what hazardous means. *(Hazardous means dangerous. **Hazardous wastes** products and materials leftover from the manufacturing process that are likely to cause harm to the environment or humans because they are either **toxic,** which means poisonous; **combustible** or **flammable,** which means they burn easily; **reactive,** which means they explode easily; or **corrosive,** which refers to substances that rapidly eat into and/or dissolve what they touch.)*

Ask: Does this mean that you will get sick from handling or riding your bike? Why not? What happened to the hazardous by-products and wastes produced when your bike was made? *(Some were captured and recycled for industrial reuse. Some are captured and disposed of in hazardous waste disposal sites. Some escape into the air and water. Some are dumped or stored illegally.)*

Ask: How should hazardous wastes and by-products be managed? Why is it important to use great care in handling these wastes?

Ask: Because hazardous wastes and by-products are made when bikes are built, should we stop making bikes? What should we do that makes more sense? What are some other things that you use and buy that might also produce hazardous waste by-products when they are made?

Questions for the Class

1. What raw material is plastic and synthetic rubber made from?
2. What happens to hazardous industrial wastes?

Extension Activities

1. Have students select a popular item they use often and track down how it is made and the by-products that result.
2. Have students visit, call or investigate a manufacturing plant in your area to ask about by-products and hazardous wastes.
3. Have students write for current hazardous waste information from the U.S. EPA.

U.S. Environmental Protection Agency
Office of Communications & Public Affairs
401 M St. SW PM211B,
Washington, DC 20460

Just Do It

Learn more about by-products by writing the manufacturing facilities in your area and asking them what happens with what's left over!

Answer Sheet

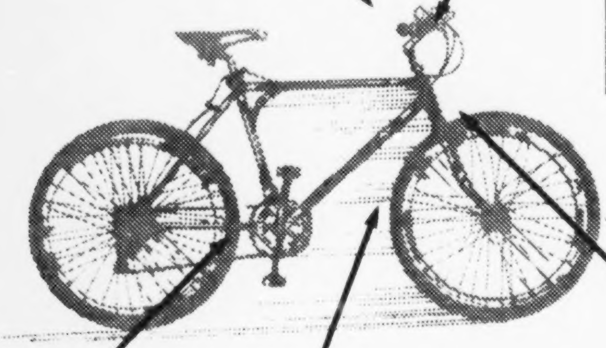
Go Ahead ... Make a Bicycle

Can you list the parts made of these materials ... can you list the by-products & waste?

Note to teachers: Don't expect students to be able to list the by-products & waste.

Chromed and Plated Metal Parts
Materials: Chrome, nickel, copper, zinc
By-products and Waste: (Highly toxic liquid wastes) Acids, chromium, zinc, copper nickel, tin, cyanides

Handle Bar Grips, Plastic Seat Cover, Synthetic Fibers, Synthetic Rubber Tires
Materials: Petroleum and petroleum distillates
By-products and Waste: Waste oil from leaks, caustic and acid sludge, alkaline and acid waters, acid gases and filtering clays



Paints and Coatings
Materials: Pigment, solvents, resins, cleaner
By-products and Waste: Paints, solvents, cleaners

Frame and Other Metal Parts
Materials: Iron ore and coal to make steel
By-products and Waste: Ammonia, tar, acids, (pickling liquor), blast furnace flue dust

Fenders and Other Metal Parts
Materials: Aluminum (from bauxite)
By-products and Waste: Large volumes of "Red Mud," consisting of iron, titanium and silica

Student Worksheet

Go Ahead ... Make a Bicycle

Can you list the parts made of these materials ... can you list the by-products & waste?

Chromed and Plated Metal Parts

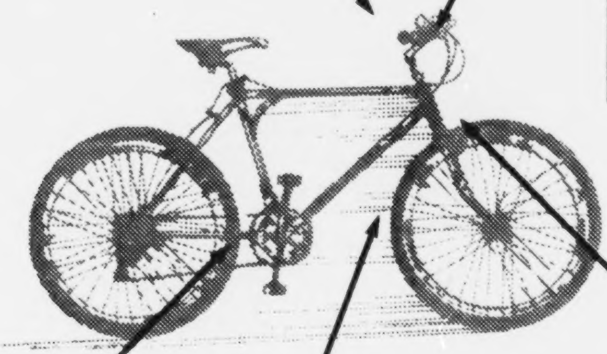
Materials:

By-products and Waste:

Handle Bar Grips, Plastic Seat Cover, Synthetic Fibers, Synthetic Rubber Tires

Materials:

By-products and Waste:



Frame and Other Metal Parts

Materials:

By-products and Waste:

Fenders and Other Metal Parts

Materials:

By-products and Waste:

Paints and Coatings

Materials:

By-products and Waste:

Hazardous Waste In My Home Town?

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 6 – 8
Focus: Hazardous waste generation, hazardous substances, community right to know
Subject: Social Studies, Geography, Economics
Materials: See list below
Teaching Time: One to four class periods
Vocabulary: Toxic and hazardous waste, by-products, bioaccumulation, acute and non-acute hazardous waste, small quantity generator

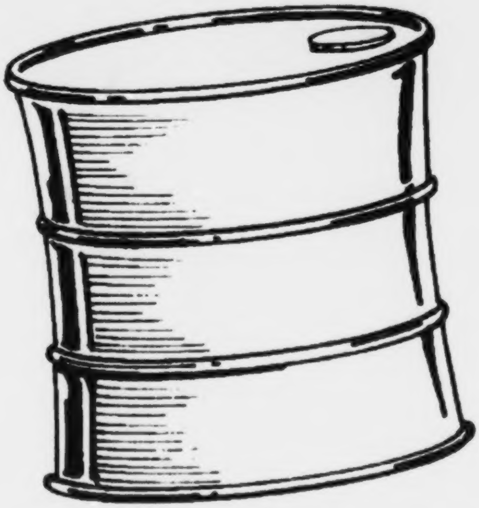
Learning Objective

Students will:

- identify local commercial and industrial waste generators
- identify ways we benefit from products or services that produce hazardous waste during the manufacturing process
- learn where to get information about hazardous waste.

Background

All businesses, large and small, generate waste, from simple office paper to tons of industrial wastes. Some of this waste is **hazardous**. The **toxic wastes** produced by large firms in the chemical, pulp and paper, and steel and aluminum industries are obvious, but many small businesses that are found in every community also generate hazardous wastes. These hazardous waste producers include such operations as auto body repair shops, photo processing shops and dry cleaners. "High-tech" companies that manufacture computer chips and electronic circuits are often thought of as "clean" industries. However, they too produce sometimes large quantities of hazardous **by-products**.



Because many areas of South Carolina are primarily agricultural, wastes from farms are a concern. Nationally, the use of farm chemicals has increased dramatically. Farmers pour 20 million tons of fertilizer on their land every year, almost triple the 1960 rate. Herbicide and pesticide use has increased nearly 64 percent since 1964.

According to state and federal regulations, a business that generates less than 220.26 pounds (100 kilograms) of non-acute hazardous waste per month or less than 2.2 pounds (1 kilogram) of acute hazardous waste per month is classified as a **small-quantity generator** of hazardous waste. An **acute hazardous waste** is waste that poses a more serious threat to human health and the environment. Examples of an acute hazardous material would be fluorine and sodium cyanide. Any other type of hazardous waste, such as substances with less than five parts per million of lead or any amount of TCE (tetrachloroethylene), is classified as **non-acute**.

DOWN TO EARTH

Industry produces nearly twice as much hazardous waste and 42 times as much solid waste as households in the United States.

Source: 1993 Environmental Almanac

Small-quantity generators may send their waste either to a specially designed hazardous waste landfill or to the local sanitary landfill without having it specially treated. They also do not have to submit quarterly reports or obtain a U.S. EPA identification number.

Companies that generate between 220.26 pounds (100 kilograms) and 2,202.64 pounds (1,000 kilograms) of non-acute hazardous waste each month or between 2.2 pounds (1 kilogram) and 220.26 pounds (100 kilograms) of acute hazardous waste each month are considered regular small-quantity generators. While these companies are not subject to quarterly reporting requirements, their waste must be treated prior to disposal in specially designed hazardous waste landfills. Companies who create more than these monthly quantities of hazardous waste, acute or non-acute, are no longer considered small-quantity generators. South Carolina has approximately 900 small-quantity generators. (For more information on hazardous waste, see the Resource section. You can also contact DHEC at 1-800-76-USE-IT for its annual report entitled *Hazardous Waste Activities Reported in South Carolina.*)

Materials

Teacher/Classroom materials

- Local telephone yellow pages
- South Carolina Industrial Directory (Available in most public libraries. Call the South Carolina Department of Commerce in Columbia at (803) 737-0400. If you can't locate a copy, the Department of Commerce can send you information about your county.)
- Transparency or handout: *Some Industrial and Commercial Hazardous Waste Categories* (Answer key)
- EPA brochure *Protecting Our Ground Water*, Environmental Protection Agency, Office of Public Affairs, Washington, D.C. (optional)

Student materials

- Map of your community or county, contact the city or county planning office (optional)
- Handout: *Businesses Generating Hazardous Materials*
- Handout: *Some Industrial and Commercial Hazardous Waste Categories* (blank worksheet)

Questions for the Class

1. What characteristics make waste hazardous?
2. What are three types of small businesses that generate hazardous waste?
3. What are heavy metals and why are they hazardous?

Learning Procedure

1. Ask students to think of as many different kinds of businesses and industries in their area as possible. Use the Yellow Pages, the South Carolina Industrial Directory, or ask your Chamber of Commerce for information. Make sure that both large and small businesses are included.

As local businesses and industries are identified, have students describe what products or services these enterprises provide. Tabulate the number and kind of industries on the board.

Discuss how these products or services benefit us. *(For example: dry cleaners clean our sweaters and suits; automotive body shops repair or customize our cars; printing shops prepare brochures, flyers, newspapers, etc., that keep us informed.)*

2. **Ask:** What wastes might be produced by these local businesses and industries? How are these wastes managed? *(They're either recycled, go to a landfill, or are released into the sewage system for treatment. If they are hazardous, they may be reused, recycled, stored, treated, disposed of by way of a hazardous waste landfill or incinerator, and some are disposed of illegally.)*

3. **Ask:** What qualities might be characteristic of a hazardous waste? Under what conditions can a hazardous waste pose a threat to human or animal life? *(For example: persistent substances lasting a long time in the environment before being broken down into something less hazardous; long-term*

exposure to certain substances at low levels: ***bioaccumulation*** *of substances; reactive effects; heightened sensitivity of certain groups of people to specific substances, such as young children to lead, a heavy metal.)*

4. Distribute copies of the handout *Businesses Generating Hazardous Materials.* **Ask:** Did we find any of these kinds of businesses in our community?

5. Pass out copies of the blank *Some Industrial and Commercial Hazardous Waste Categories* sheet. Ask students to match the categories with the hazard characteristics discussed by filling in the "blank" column. Explain that any category may have more than one characteristic, or may have long-lasting dangers or affect certain groups of people. Ask students to think of ways wastes might cause harm. This can be done individually or in groups using brainstorming techniques. Give students ten minutes or so to work on their answers. Using the *Some Industrial and Commercial Hazardous Waste Categories* answer key, go over students' answers. **Ask:** How can we find out more about the hazardous wastes generated in our community?

6. Identify the S.C. Department of Health and Environmental Control as a good source of information about hazardous substances and hazardous waste. Tell students that a hazardous *product* becomes a hazardous waste when it is no longer wanted or useful and is destined for disposal. While the product is still considered useful, it is termed a hazardous *substance.* Discuss the principle that all citizens have a right to know about hazardous substances in their community.

7. Distribute the U.S. EPA brochure *Protecting Our Ground Water.* **Ask:** What are some of the ways wastes can enter the environment? Distribute maps of your town or county, or have students draw maps. Have students locate and mark the local landfill, and sewage treatment plants. Have them highlight streams, lakes, and salt water. Discuss the significance of these locations. **Ask:** Is hazardous waste generated near any of these sensitive areas?

8. Using the list of businesses, have students mark the locations where hazardous wastes might be produced on their maps. When maps are complete, **Ask:** Which areas in our town or county are most vulnerable or sensitive to pollution? *(Aquifers and wetlands, for example.)*

9. **Ask:** What can we do to prevent pollution? How can we ensure that our environment and human or animal health are not endangered due to hazardous wastes in our communities? Explain to students that, to protect public health and the environment, hazardous waste is managed by a system much stricter than for non-hazardous waste.

Explain that the S.C. Department of Health and Environmental Control is responsible for regulating hazardous waste and that one part of this responsibility is the monitoring of businesses that produce hazardous waste.

Extension Activities

1. Have students call or write the S.C. Department of Health and Environmental Control with questions about the wastes that may be generated or the hazardous substances stored in their community. Or contact the U.S. EPA at 1-800-535-0202.

2. Assign a particular waste or waste-generating business to a group of students to research. For example, a group (or individual) might try to find out what are the specific hazards associated with the wastes generated by auto detailing shops, print shops, or dry cleaners.

Just Do It

Have students investigate the hazardous substances used and hazardous wastes generated by the school in chemistry labs and shop classes.

Businesses Generating Hazardous Materials

Type of Business	Hazardous Wastes Generated
Auto Repair and Maintenance	Acids/Bases Heavy Metals Solvents
Building Cleaning and Maintenance	Acids/Bases Solvents
Cleaning Agents and Cosmetics	Acid/Bases Heavy Metal/Inorganics Solvents
Construction	Acids/Bases Solvents Preserving Agents
Electric and Computer Chip Manufacturers	Acids/Bases Spent Plating Wastes
Farmers and Agricultural Service Shops	Pesticides Solvents
Furniture/Wood Manufacturing/ Refinishing	Solvents
Laundries and Dry Cleaners	Dry Cleaning Filtration Residues Solvents
Motor Freight Terminals and Rail Transport	Acids/Bases Lead-Acid Batteries Heavy Metals/Inorganics Solvents
Printing Industries	Acids/Bases Heavy Metals/Inorganics Ink Sludges Spent Plating Wastes
Schools, Labs, and Vocational Shops	Acids/Bases Solvents Heavy Metals/Inorganics
Wood Working (Lumber mills, etc.)	Preserving Agents

Some Industrial and Commercial Hazardous Waste

Categories - Answer Key

Waste Category	Hazard Characteristic(s)	Other Considerations
Acids/Bases	Corrosive, Reactive	Can sometimes react violently with water
Cyanide Wastes	Toxic	
Filtration Residues	Corrosive, Reactive, Toxic	
Formaldehyde	Toxic	Sensitive populations - (1)
Heavy Metals and Inorganics	Toxic	Persistent; sensitive populations - (2)
Ink Sludges	Toxic	Persistent; sensitive populations - (2)
Oils (used)	Toxic	Persistent; sensitive populations
Pesticides	Toxic	Persistent- (3)
Preserving Agents	Toxic, Corrosive	
Solvents/ Degreasers	Corrosive, Reactive, Ignitable, Toxic	Sensitive populations - (1)
Spent Plating Wastes	Corrosive, Toxic	

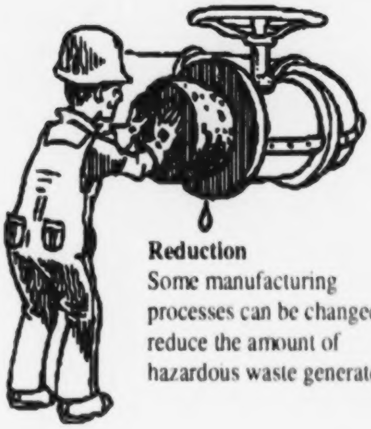
1. Some individuals are especially sensitive.
2. Children are especially at risk to lead exposure.
3. Chlorinated pesticides can bioaccumulate.

Some Industrial & Commercial Hazardous Waste Categories

Worksheet

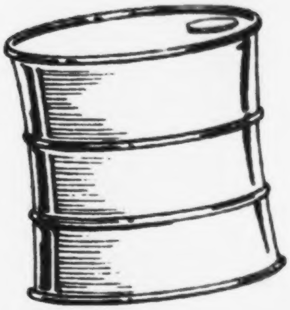
Waste Category	Hazard Characteristic(s)	Other Considerations
Acids/Bases		
Cyanide Wastes		
Filtration Residues		
Formaldehyde		
Heavy Metals and Inorganics		
Ink Sludges		
Oils (used)		
Pesticides		
Preserving Agents		
Solvents/ Degreasers		
Spent Plating Wastes		

Handling Hazardous Waste ... Safely.



Reduction
Some manufacturing processes can be changed to reduce the amount of hazardous waste generated.

Bioremediation
Microscopic organisms, known as "bugs," consume the hazardous waste material.



Recycling
Some hazardous wastes can be reused to make other useful products.

Chemical Treatment
Certain hazardous wastes can be made less hazardous by specially treating them with chemicals.

Incineration
Burning at high temperatures destroys some hazardous wastes.

Landfilling
After hazardous wastes have been treated, they can be safely buried in special landfills.

Action for a cleaner tomorrow.

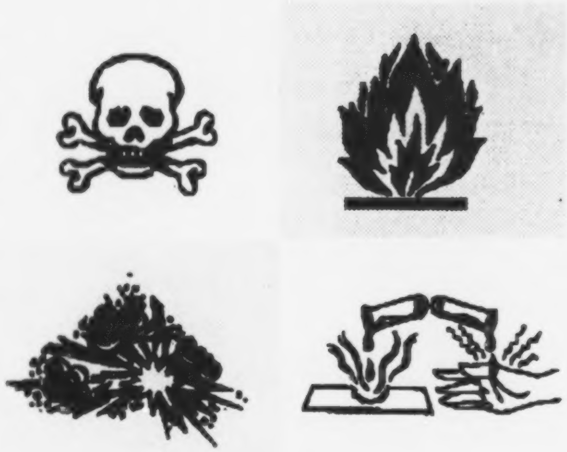
A South Carolina Environmental Curriculum

For more information about South Carolina and the environment. call the South Carolina Department of Health and Environmental Control at 1-800-768-7348.

Signs of the Times

Preparation Time: **Easy-To-Do** Moderate Extensive

Grade: 6 - 8
Focus: Hazardous awareness and identification
Subject: Language Arts, Social Studies
Materials: See list below
Teaching Time: One to two class periods
Vocabulary: Hazardous materials, DOT, placard, nonverbal communication



Learning Objective

Students will:

- demonstrate a knowledge of how design and color are used as symbols for things, places or ideas
- apply the knowledge of symbol language to hazardous material identification placards
- synthesize the information by writing a short narrative
- compare and contrast a written narrative to placard symbols.

Background

In the United States, **hazardous materials** are transported daily by trucks and trains. Often citizens are not aware that these materials are being moved through their communities until an accident occurs.

The packaging and transporting of hazardous materials are regulated. Each truck carrying these materials is required to display a **placard** describing the category of the hazardous material it is carrying and, sometimes, the specific material.

Placards used for this purpose must comply with United States Department of Transportation (**DOT**) design and color regulations. The use of design and color to communicate a message or idea is called "symbol language"— one form of **nonverbal communication**. The purpose of this activity is for students to heighten their awareness of symbol language and have them apply that knowledge to the use of design and color in hazardous materials placards displayed on trucks.

Materials

Samples of logos and symbols, colored pencils, crayons, or markers (red, orange, yellow, blue, and, green); student sheets. *Optional:* Hazardous Materials Product Kit, available from J.J. Keller & Associates, Inc., P.O. Box 368, Neenak, WI 54956-0368

Procedure

1. Ask the students to identify designs or logos that are used as symbols to represent businesses in their community. (For example, McDonalds, Ford, Coke or Pepsi.) Students might think of other symbols that represent restaurants, clothing and car manufacturers, or food products.

DOWN TO EARTH

United States' industries annually generate nearly two tons of toxic waste for every man, woman and child in America.

Source: *50 More Things You Can Do To Save The Earth*

2. Ask the students to name frequently used designs that represent ideas, as opposed to companies or products. Students might think of designs used for highways, traffic signals, countries, churches, political parties, holidays, or seasons.

3. Have the students develop associations related to the symbols until they become sentences and fully developed ideas, if possible. Each time the class determines the "message," follow the answers with. "And what does that mean to you?" To demonstrate an example, draw a snowflake on the board as a symbol representing "snow." Snow means cold, winter, no school.

4. Explain to the students that a design can be used as a symbol, as can color.

Ask the students how the color "green" is used as a symbol, what it means and what associations are made with that symbol. For example, a green traffic light means go; green highway signs mean cities or exits; green can symbolize a season *(spring or summer)* or a holiday *(St. Patrick's Day)*.

5. Explain to the students that symbol language is one form of nonverbal communication *(communicating a message without using words)*.

6. Give each student a copy of the student sheet *Symbols: Hazardous Materials*, included. **Ask:** Has anyone seen these symbols before? Where? Why are some materials required to carry these labels? Why are symbols used to represent these categories of hazardous materials?

A. Give each student a copy of the student sheet *Placards and Labels: Hazardous Materials*, included. **Ask:** What does "placard" mean? *(A placard is a poster used to display a message.)* Note the colors assigned by the United States Department of Transportation (DOT). **Ask:** What reasons might the DOT have for assigning those specific colors to the symbols?

B. Ask the students to examine the placards/labels on the handout. Explain that the numbers at the bottom represent a hazardous chemical classification system. The United Nations' Hazard Class Numbers are displayed at the bottom of the placards. The number may be used in place of the written names of the hazardous chemical classes:

2	Gases
3	Flammable liquids
4	Flammable solids
	- Spontaneously combustible
	- Dangerous when wet
5.1	Oxidizers
5.2	Organic peroxides
6	Poisonous
7	Radioactive
8	Corrosive

Compare the placards for flammable gases and nonflammable gases. **Ask:** How do colors relate to traffic lights?

7. Have the students complete the following assignment.

A. Use crayons, markers, or colored pencils to color the placards according to regulations.

B. Each student should choose a placard on the handout and write a brief narrative about the contents of a truck or a train that is transporting hazardous material. Without revealing the design, color words, or numbers on the placard displayed by the transporter, the narrative should describe the contents in such a way that another person could use its clues to identify which placard was on the vehicle.

C. Have the students exchange narratives. Using the clues in the narrative and referring to the handout about placards, students are then to identify the placard that would be on the transporter.

Questions for the Class

1 . Define nonverbal communication.

2. Name two elements of symbol language and give an example of each.

3. What elements of symbol language are used to identify hazardous materials that are being transported?

4. What symbols are used for the four major categories of hazardous materials?

5. Why it is important for people to understand the messages of the placards on vehicles transporting hazardous materials?

6. How could you help others become familiar with these symbols?

Extension Activities

1. Divide the class into four teams. Each team is to document the sighting of as many hazardous materials placards or labels as possible within a given geographic location. The sighting documentation must include date, time, and location of the sighting, plus a description of the placard color and number.

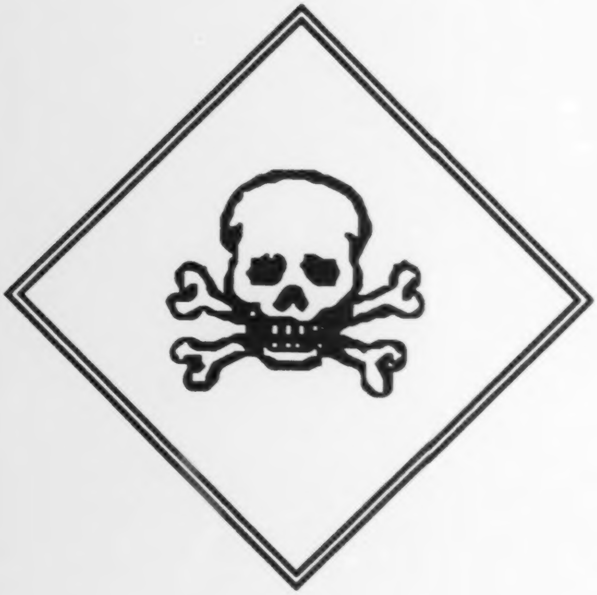
2. Assign each team a color and have cards corresponding to each color. Have team members write down their sightings, one to a card, and place them — one card at a time and one team at a time — in order on the Bingo board (included). The first team to get five in a row wins.

Student Sheet

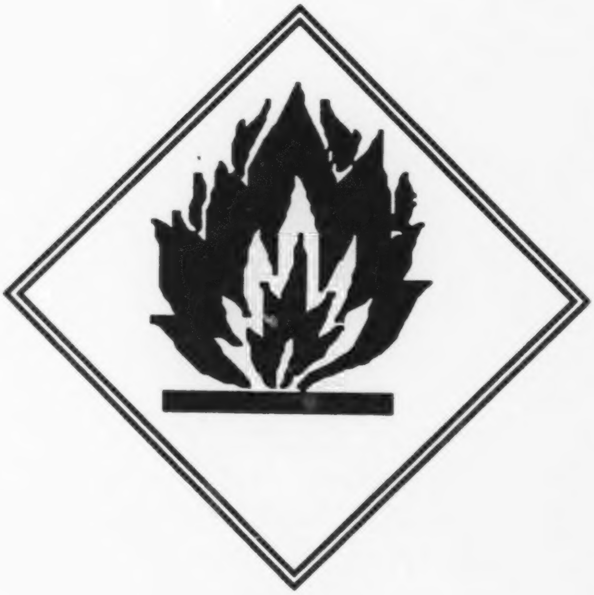
HAZARDOUS LABELS: TERMINOLOGY

Category	Placard Terminology	Definition
Toxic	Poison	Causes illness, injury or death
	Poison Gas	A gaseous substance that causes illness, injury or death
	Irritant	Causes swelling, soreness or roughness
	Chlorine	A highly irritating gas
Reactive	Combustible	Capable of igniting and burning
	Dangerous when wet	Reacts violently with water
	Oxygen	A gas required for combustion
	Oxidize	May ignite other combustible materials
	Organic Peroxide	An oxidizer that may explode at low temperature
	Explosive	Capable of exploding at standard temperature and pressure
Ignitable	Flammable Liquid	A liquid that is capable of burning rapidly
	Flammable Solid	A solid material that is capable of burning rapidly
	Flammable Gas	A gaseous substance that is capable of burning rapidly
Corrosive	Corrosive	The pH level is below 2 or above 12.5; capable of causing materials — metals especially — to break down or dissolve

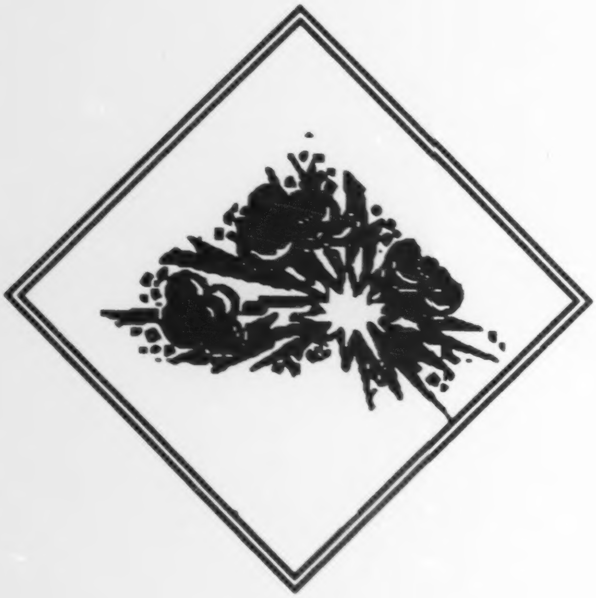
Symbols



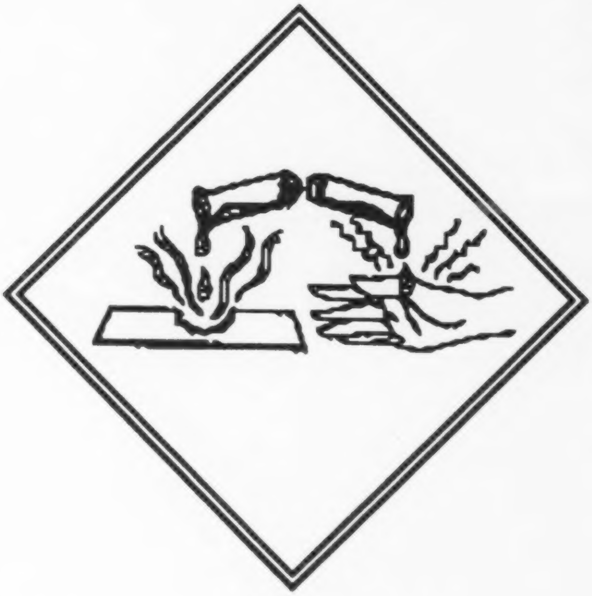
Poison



Flammable

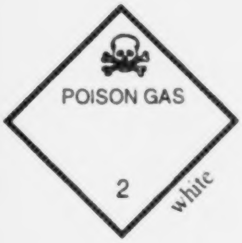


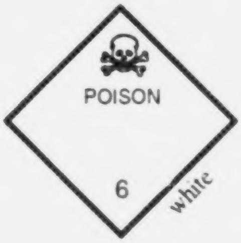
Explosive

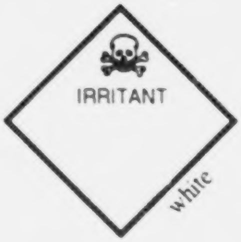


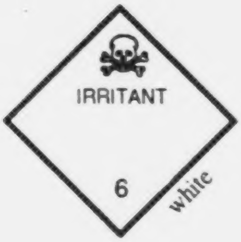
Corrosive

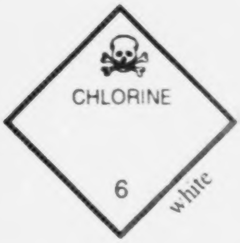
Placards and Labels: Hazardous Materials

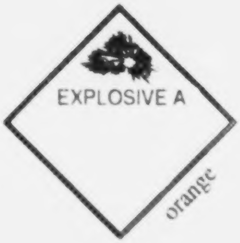

POISON GAS
2
white

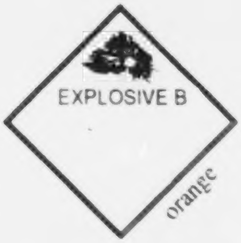

POISON
6
white

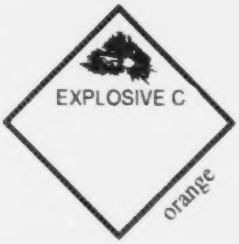

IRRITANT
white

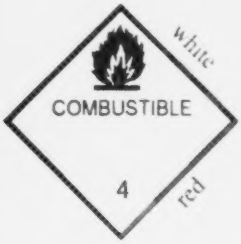

IRRITANT
6
white

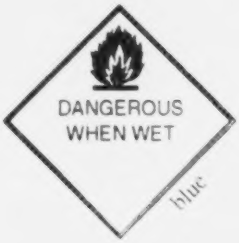

CHLORINE
6
white

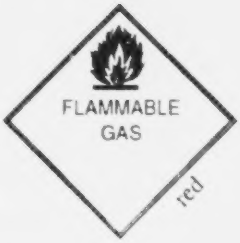

EXPLOSIVE A
orange

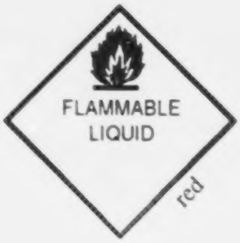

EXPLOSIVE B
orange

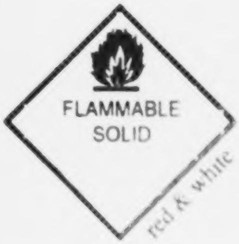

EXPLOSIVE C
orange

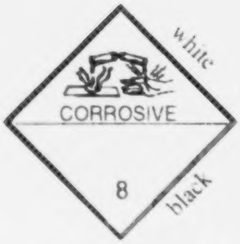

white
COMBUSTIBLE
4
red


DANGEROUS
WHEN WET
blue


FLAMMABLE
GAS
red


FLAMMABLE
LIQUID
red


FLAMMABLE
SOLID
red & white

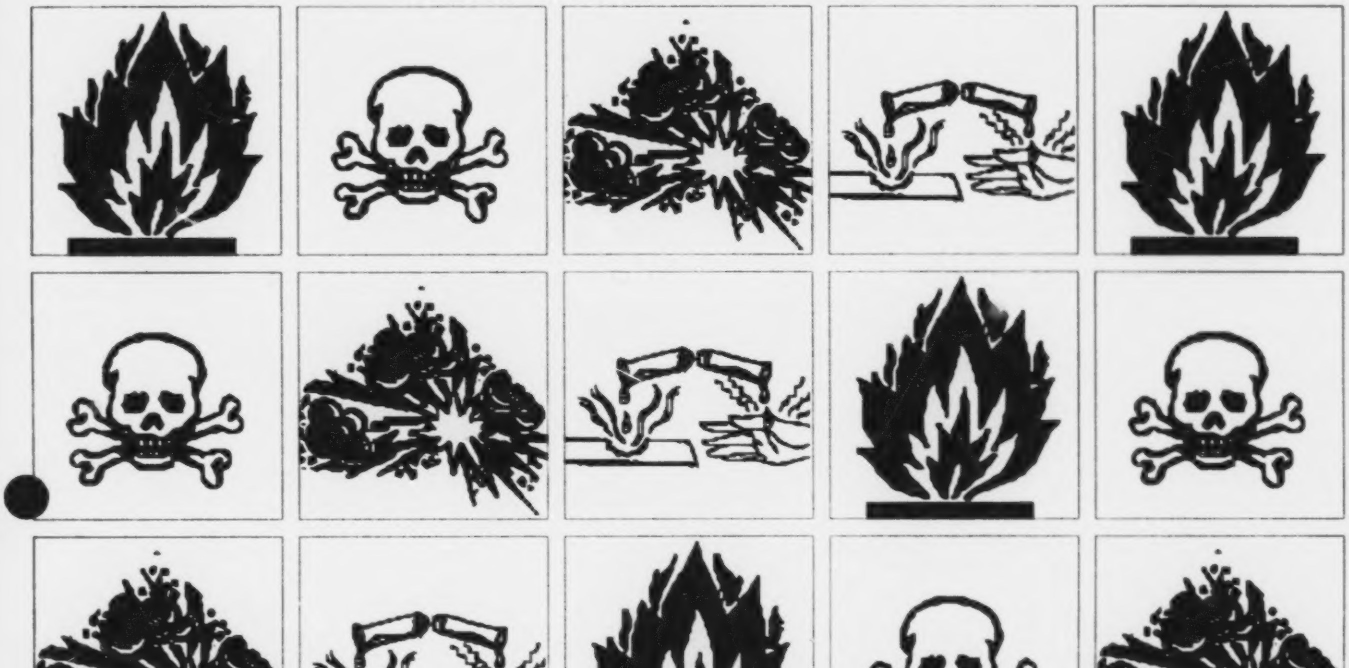

white
CORROSIVE
8
black

Note: These Placards and Labels are some of the most common identifiers of hazardous materials. There are many others and the list changes as materials are added.

Signs of the Times

Bingo

When you spot one of these Hazardous Waste Truck Placards, make a note of the type of placard, time, date, and location. Write it on your team's card and place it over the type of placard you saw. The first team to get five in a row wins!



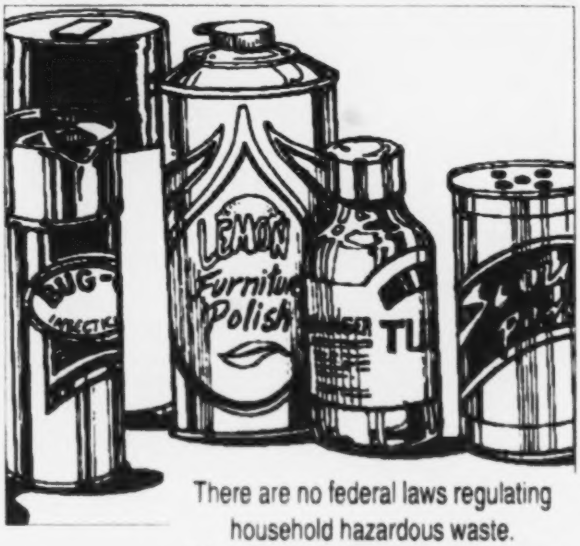
TANK PLACARDS: IDENTIFICATION NUMBERS

Identification Number	*Chemical Name*	*Placard Symbols*
1001	Acetylene	Flammable Gas
1005	Anhydrous Ammonia, Liquefied	Nonflammable Gas
1008	Boron Trifluoride	Nonflammable Gas
1017	Chlorine	Chlorine
1036	Mono Ethylamine	Flammable
1046	Helium or Helium Compressed	Nonflammable Gas
1049	Hydrogen or Hydrogen Compressed	Flammable Gas
1050	Hydrogen Chloride	Nonflammable Gas
1072	Oxygen or Oxygen Compressed	Nonflammable Gas
1073	Oxygen, Refrigerated Liquid	Oxygen
1075	Liquefied Petroleum Gas	Flammable Gas
1078	Refrigerant Gas, N.O.S	Nonflammable Gas
1090	Acetone	Flammable
1114	Benzene	Flammable
1133	Cement Liquid, N.O.S	Flammable
1142	Compound Removing Liquid	Flammable
1170	Ethyl Alcohol	Flammable
1203	Gasoline, Gasohol, or Motor Fuel, N.O.S	Flammable
1230	Methyl Alcohol	Flammable
1247	Methyl Methacrylate (Monomer)	Flammable
1255	Petroleum Naphtha	Flammable
1263	Paint, Shellac, Thinner, or Varnish	Combustible
1267	Crude Oil Petroleum	Flammable
1270	Oil, N.O.S. or Petroleum Oil	Combustible
1719	Alkaline Liquid, N.O.S.	Corrosive
1760	Numerous Corrosive Chemicals	Corrosive
1789	Hydrochloric or Muriatic Acid	Corrosive
1790	Fluoric or Hydrofluoric Acid Solution	Corrosive
1791	Hypochlorite Solution	Corrosive
1805	Phosphoric Acid Solution	Corrosive
1814	Potassium Hydroxide Liquid or Solution	Corrosive
1824	Sodium Hydroxide Liquid or Solution	Corrosive
1830	Sulfuric Acid	Corrosive
1831	Oleum	Corrosive
1832	Sulfuric Acid, Spent	Corrosive
1840	Zinc Chloride Solution	Corrosive
1863	Fuel, Aviation, Turbine Engine	Combustible
1866	Resin Solution	Flammable
1917	Ethyl Acrylate, Inhibited	Flammable
1962	Ethylene	Flammable Gas
1966	Hydrogen, Refrigerated Liquid	Flammable Gas
1977	Nitrogen, Refrigerated Liquid	Nonflammable Gas
1993	Flammable Liquid, N.O.S	Flammable
1993	Combustible Liquid, N.O.S	Combustible
1999	Tar Liquid, Asphalt, Cut Back	Flammable
1999	Tar Liquid, Asphalt, Cut Back	Combustible
2031	Nitric Acid (Over 40%)	Oxidizer
2055	Styrene Monomer, Inhibited	Flammable
2067	Ammonium Nitrate Fertilizer	Oxidizer
2187	Carbon Dioxide Liquefied	Nonflammable Gas
2209	Formaldehyde Solution (Formalin)	Combustible
2218	Acrylic Acid	Corrosive
2426	Ammonium Nitrate Solution	Oxidizer
2582	Ferric Chloride Solution	Corrosive
2789	Acetic Acid, Glacial	Corrosive
2790	Acetic Acid (Aqueous Solution)	Corrosive

Making Hazardous Waste Decisions

Preparation Time: Easy-To-Do Moderate **Extensive**

Grade: 6 – 8
Focus: Improper disposal of hazardous waste is harmful to the environment
Subject: English, Drama, Social Studies
Materials: Handouts included with lesson
Teaching Time: One class period, outside class research (optional)
Vocabulary: Hazardous waste



There are no federal laws regulating household hazardous waste. Education is the most effective means of ensuring that people use and dispose of products safely.

Learning Objective

Students will:

- examine common disposal practices
- gain an appreciation of better disposal options.

Background

Hazardous waste is waste that may pose a threat to human health or the environment. The disposal, transportation and handling of hazardous waste is regulated by federal law. However, many of the materials found in every day household products are considered to be hazardous substances and, when they are thrown away in the household garbage, are then considered to be household hazardous waste. For more information on hazardous materials, see the lesson entitled *Hazardous Waste in My Home Town* and the Resource section.

Learning Procedure

1. Distribute handouts: *Where Does It Go?*, *Where Should It Go?* and *What About All Those Household Products?* Discuss the information and have the students list some hazardous products they have in their homes.

2. Tell the students they are going to role play the decision-making process for dealing with some common household hazardous substances. Remind students that there are many different views on what to do with hazardous wastes. Divide the class into three groups and assign each a different scenario. Use the Character Cards with this lesson to assign roles. As an option, you may make the character assignments ahead of time and have the students provide costumes and props to support their roles. For example, in Scenario #1, the character, Lt. John Jones of the local fire department could wear a firefighter's hat and a rain coat, and carry a hose. You may want to award extra credit points for students who "get into character."

DOWN TO EARTH

In household hazardous waste collection programs in the United States, each household contributes an average of 100 pounds (45 kilograms) of these materials.

Source: Dana Duxbury, president of a national clearinghouse on household waste.

SCENARIO #1: Sally discovers a can of gasoline in her garage. What should she do with it?

SCENARIO #2: A group of neighbors is setting up a community gardening project. They have purchased the plot of ground and are meeting to make some decisions about how the garden will run.

SCENARIO #3: Nine individuals have decided to combine their talents to create the Zippy Cleaning Service. As a group they need to decide what products they will use .

3. Each student should get one card listing a possible reaction to the question and/or issue raised in their scenario. They must represent that point of view in a group discussion on how the situation should be handled. Point out to the students that there is not necessarily one correct answer to these problems. These are current situations for which the state — and society at large — are trying to find a good solution.

4. Allow 30 minutes for discussion, at which time each group should make a recommendation concerning their particular dilemma. Have an assigned reporter keep track of the discussion (on the attached Decision Sheet) to tell the class what factors were considered prior to achieving a consensus.

Extension Activities

1. After completing one set of scenarios, allow the groups to discuss the other scenarios. Compare the final recommendations and the decisions made to reach those conclusions. How did they differ?

2. Have the students write an essay on how they would respond to one of the three scenarios.

3. Ask students to take the handout *What About All Those Household Products?* and share it with their parents.

4. Have the students make a diagram of their homes indicating all avenues for disposal of household hazardous materials and where the material goes. This should trace, for example, the route of materials poured down the kitchen sink from septic tank to leach field or, when pumped, to a treatment facility, etc.

Did You Know …

- About 2 to 4 percent of all wastes generated in the United States are hazardous.
- Never throw household hazardous waste in the garbage or down the drain.
- Store hazardous materials in a cool, dry place, out of children's reach; and keep them in their original containers to avoid misuse.
- Do not mix hazardous materials.
- Use safe alternatives whenever possible.
- If you have a question about proper disposal, call S.C. DHEC's Office of Solid Waste Reduction and Recycling Hot Line at 1-800-76 USE IT.

5. Write for more information on hazardous wastes.
National Solid Waste Management Association
1730 Rhode Island Avenue, NW
Suite 1000
Washington, D.C. 20036
(202) 659-4613

Just Do It

Conduct a hazardous waste inventory of your home.
Replace as many of these products with non-hazardous substitutes as you can.

Where *Does* It Go?

When you wash your clothes in sudsy detergent, where does it go? When you clean your sink with cleanser, where does it go? When you pour a waste into the street drain, where does it go? It doesn't disappear; it all goes somewhere.

All the drains in your house lead from the bathroom, kitchen, and laundry room down to one large drain. If you live in the country, the watery wastes pass into a septic tank. A septic tank is a large underground concrete container. Wastewater spends two or three days there. Solids settle to the bottom of the tank. Liquids are piped into a drainfield which allows them to seep slowly into the soil. This soil sludge must be pumped out approximately every five years. It is then taken to a sewage treatment plant.

If you do not have a septic tank, then your wastewater is piped from your house to the sewage treatment plant. Underground pipes mix the liquids from homes, stores, businesses, and factories. At the sewage plant, wastewater is treated with bacteria. This can remove a majority of the harmful materials. Then the waste is diluted with water and discharged into nearby lakes or streams. All water discharged is required to meet state and federal purity standards and is monitored and tested frequently.

Pouring wastes into storm drains is wrong. They lead directly to waterways. Many chemicals and other wastes such as oil are dangerous, they can harm fish, or poison humans who eat the fish or drink the water.

Dumping wastes on the ground pollutes the soil. As the poison seeps into the soil, groundwater supplies may be ruined.

Burning toxic wastes in the backyard is not a good idea either. Harmful gases contaminate the air. Aerosol cans will explode.

There are two good solutions to toxic wastes. Buy and use as few hazardous materials around your home as possible. Then dispose of any leftover hazardous materials at a Toxic Cleanup Day, or according to disposal directions on the label.

Where *Should* It Go?

How do you dispose of items you do not need? It is preferable to buy any hazardous product in only the quantity you need and can use, but when you do need to dispose of a hazardous product, do it responsibly. Here are some alternatives to disposing of these items in your household garbage can. Never put hazardous substances in your garbage can.

Down The Drain With Lots of Water

powder cleaners
window cleaner
toilet cleaner
bleach

Evaporate Small Amounts Outside, Away From Children and Pets. Then Throw the Residue in the Garbage Can

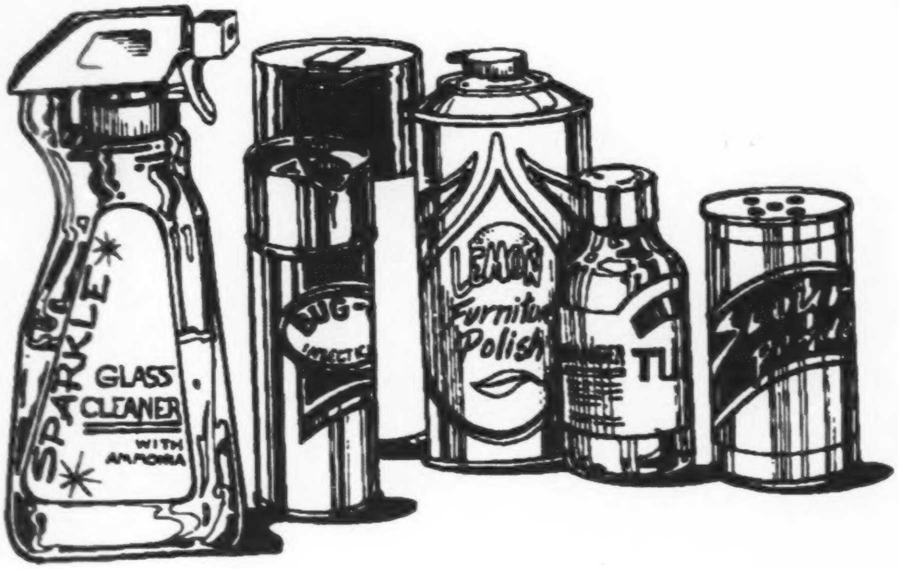
latex paint (Large quantities of leftover latex paint can be donated to a local charity.)

Take To A Household Hazardous Waste Collection Site

pool cleaning agents
drain cleaner
silver polish
flea powder
kerosene
auto antifreeze
mothballs
spot removers
household insecticides
rat poison
paint stripper

Recycle

car batteries



Problem Solving Exercises

Scenario #1 Character Cards: Sally's Can of Gasoline

Scenario #1

You are Sally's neighbor, Nancy Nextdoor. You know that gasoline evaporates. Maybe Sally should just let the gas evaporate. But you know the fumes are a dangerous poison. There are small children in the neighborhood, and you wonder if evaporation might cause some air pollution.

Scenario # 1

You are Lt. John Jones of the local fire department. It is very dangerous to store gasoline. It is a fire hazard.

Scenario #1

You are Sally's brother-in-law, Fred. You tell Sally that gasoline is an effective weed killer. Sally has a large patch of blackberries in the corner of her lot. Maybe she should throw the gasoline on the ground around the berries.

Scenario # 1

You are Joe Cleandrain from the sewage treatment plant. You tell Sally that it is against regulations to pour gasoline down the sink, sewer, or storm drains.

Scenario #1

You are Pat, Sally's neighbor. You know that gasoline is a solvent. How could Sally use a solvent? You suggest that Sally check with a recycling center that takes solvents. But, the only one you know of is 25 miles (40 km) away, clear on the other side of the county.

Scenario #1

You are Chris, Sally's son's friend from school. You say that your dad has always poured his excess gas down the storm drain in front of the house. It is such a small quantity that it can't possibly hurt anything.

Scenario #1

You are Peter Putrescible, a representative of the community landfill. You tell Sally that the landfill will not accept flammable materials.

Scenario #1

You are Sally. You discovered a can of gasoline in your garage while you were cleaning. You don't know exactly how long it has been there. Because you are worried it may have water, oil, or rust in it, you have decided not to use it in your lawnmower.

Scenario #1

You are Sally's son, Ralph. Another friend of yours says that his dad is glad when he has excess gasoline around. He uses it to start the backyard grill.

Problem Solving Exercises

Scenario #2 Character Cards: The Community Garden

Scenario #2

You are Bob Tool. You own the Valley Hardware & Garden Store. You know that Metaldehyde is the active ingredient in slug baits. It was first discovered in 1936 and has been around for a long time.

Scenario #2

You are Sally Street. You have used salt on the slugs in your own garden. Last year you used saucers of beer to get rid of them. Although it worked pretty well, the saucers had to be changed often and sometimes it seemed like too much work.

Scenario #2

You are Sandy Beach. You read in a gardening magazine that kelp or seaweed laid around the edges of the garden would get rid of slugs. They crawl over the salty surface of the seaweed and the salt causes them to dry out and die.

Scenario #2

You are Polly Puregard. You checked with the Community Garden Association. They don't allow any chemicals in their community gardens. If this project allows chemicals, you don't want to participate.

Scenario #2

You are Ned Punchly. You suggest that boards be laid around each bed. The slugs will crawl under them during the day and someone can turn the boards over to collect or kill them. Or the group could elect a member to go out at night with a flashlight and collect them.

Scenario #2

You are Susan Feathers. You recommend the group build two fences; one right around the garden and another 2 or 3 feet (approx. 1 meter) away from the first. The group could put ducks and geese in this enclosed area. They would eat the slugs before they could get into the garden.

Scenario #2

You are Rita Byeby. You recommend planting sacrificial rows of bok choy, lettuce, cabbage, or other vegetables, all around the perimeter of the garden. These vegetables will keep the slugs busy and they will never get into the "real" garden.

Scenario #2

You are Dudley Duread. You read the label from a slug bait container and know that it is toxic to pets. Some pets have been poisoned by accidentally eating it in the garden. You also discovered that you are supposed to keep it away from the edible parts of the vegetables. What does this mean?

Scenario #2

You are John Goodgardner, who has tried for years to garden with a minimum of chemical pesticides and fertilizers. But last year the slugs got your lettuce, a real disappointment. You want the project to work and everyone to accept the decisions the group makes.

Problem Solving Exercises

Scenario #3 Character Cards: The Zippy Cleaning Service

Scenario #3

You are Annie Aerosol and are very concerned about aerosol cleaners. You know they are popular but not very cost efficient. Small droplets can land on other objects besides those being cleaned and some propellants can damage the ozone layer around the earth. Disposal of aerosol cans also creates problems because they may explode if they get too warm.

Scenario #3

You are Priscilla Polish and have been looking into the amount of hydrocarbons, petroleum distillates, and napthas in polishes and cleaners. You have found that they can cause skin rashes, as well as eye, nose, throat, and lung irritation. They are also hazardous when ingested. Repeated exposure can result in liver and kidney damage.

Scenario #3

You are Granny Smith and have researched some alternatives to conventional cleaners. For example, several teaspoons of vinegar in water works well for cleaning glass and marble. Baking soda is recommended for items that are particularly greasy, such as pots, chrome, and tile.

Scenario #3

You are Tom Smellnice and are concerned about disinfectants and deodorizers that end up down the drain or in the air after they are used. You realize that these products do not create a germ-free environment anyway. You also wonder about toilet bowl cleaners that are flushed into the sewer or septic tank. Does this create a problem?

Scenario #3

You are Carl Caustic and are concerned about alkalies found in dishwashing and laundry detergents, and oven and drain cleaners. Swallowing these can cause severe stomach pains and burns in the mouth and throat. Inhalation can cause severe coughing and burns to the throat and lungs. Skin and eye contact can cause burns and damage to the cornea.

Scenario #3

You are Bob Bleach and have researched alternatives to commercial disinfectants. You have found that l/4-cup (59 ml) of bleach in 1 quart (0.9 L)of water works well for cleaning many surfaces including counter tops, floors, toilet bowls, and bathtubs.

Scenario #3

You are Jack Cleanwater and are concerned about the phosphates in detergents, as well as the cleaning agent, TSP. You heard that phosphates can threaten the health of lakes, rivers, and streams by encouraging algae growth.

Scenario #3

You are Cloris Toxgas and are concerned with the human health hazards of chlorine. It is the basic ingredient of some bleaches and drain cleaners, and can cause burns and surface damage to eyes. If mixed with an acid or ammonia, a highly toxic gas is produced. Inhalation is especially dangerous to those with lung problems and can result in death.

Scenario #3

You are Lisa Lemon and have researched some alternatives to commercial furniture polishes and recommend:

1 teaspoon lemon oil
1 pint mineral oil

or equal parts of:

turpentine, boiled linseed oil, and vinegar, plus a few drops of lemon oil for fragrance.

Problem Solving Exercises

Decision Sheet

Which Scenario? ______________________________

Students in the group: ______________________________

After each person in the group contributes information and the entire problem unfolds, what do you see as the ISSUES in this exercise? ______________________________

____

Possible Solution: ______________________________

____

____

What are some trade-offs to this solution?

____

____

____

What environmental, or human health *effects* could result from this solution?

____

____

____

Possible Solution: ______________________________

____

____

What are some trade-offs to this solution?

____

____

____

What environmental, or human health *effects* could result from this solution?

____

____

____

Possible Solution: ____________________

What are some trade-offs to this solution?

What environmental, or human health *effects* could result from this solution?

Possible Solution: ____________________

What are some trade-offs to this solution?

What environmental, or human health *effects* could result from this solution?

Final Decision: ____________________

Was the entire group satisfied with the decision? If not, why? ____________________

Note any COMMENTS and QUESTIONS that your group had during the decision-making process. Discuss these with the rest of the class.

What About All Those Household Hazardous Products?

Product

Aerosol Spray

Health, beauty, and cleaning products

Health Effects

Aerosol products release into the air particles that can be inhaled into your lungs and absorbed into your bloodstream. A chemical that is harmless to external parts of the body may be extremely dangerous if inhaled as an aerosol mist. Aerosol spray products have been associated with headaches, nausea, shortness of breath, eye and throat irritations, skin rashes, burns, lung irritations, liver damage, and heart problems. Aerosol products will explode if they are exposed to heat, causing burns and serious injury.

What You Can Do

You can buy products in a non-aerosol form. Many products come in creams, solids, liquids, or pump sprays. They can save you money; aerosol products are more expensive. If you do use aerosol products, do not inhale the fumes! Do not expose certain aerosol containers to heat. Never throw empty aerosol containers into a fire.

Product

Chlorine Bleach

Health Effects

Chlorine bleach can irritate and burn your skin and eyes. The fumes from chlorine bleach irritate your eyes and nose. Never mix chlorine bleach with ammonia, toilet bowl cleaners, or other products to make a stronger cleaning solution; the chemicals in the products may not be compatible and could produce very dangerous gases. Look for labels warning against mixing products with other products.

What You Can Do

Handle chlorine bleach with care! Better yet, mix baking soda and water to make a good cleaning solution.

Product

Detergents

Health Effects

Non-phosphate detergents can be highly alkaline and cause skin and eye irritations. They are very dangerous if swallowed.

Phosphate detergents can pollute our water systems by causing the explosive growth of algae. The phosphate acts as a fertilizer.

What You Can Do

Reduce the use of detergents. Use soap or baking soda instead.

Product
Solvents (Substances that dissolve something else)

Paint thinners, furniture strippers, dry cleaning fluids, degreasers, turpentine, and nail polish removers

Health Effects
Most solvents dissolve skin oils, causing skin irritations and damage. Solvent vapors or splashing of the liquid into the eyes can cause severe damage. The absorbency that allows contact lenses to retain medication also allows them to retain strong vapors from solvents. Instead of being washed away quickly by tears, chemicals are then held against the eyes until the lenses are removed. Lengthy exposure can cause considerable eye damage or irritation. The breathing of solvents, which evaporate quickly and enter the air, can cause nose and throat irritations, can damage lung tissue, and can enter the bloodstream through the lungs. Repeated exposure to small amounts of some solvents can cause internal damage to the liver and kidneys, which are the first line of defense against unwanted chemicals in the blood.

What You Can Do
Use solvents with utmost care and respect. If possible, use solvents outdoors. When using indoors, have plenty of fresh air and good ventilation. Never transfer solvents to unlabeled containers — especially food/drink containers.

Product
Air Fresheners

Health Effects
Air fresheners may interfere with your natural sense of smell by coating nasal passages with an oily film or with a nerve-deadening agent. Air fresheners don't eliminate room odors; they simply introduce a new smell and mask the offensive odor.

What You Can Do
Use a box of baking soda in the refrigerator to remove odors, a dish of hot vinegar to remove room odors, or a bouquet of flowers or herbs to give the room a pleasant smell.

Product
Paints

Health Effects
Chemicals in paints can irritate your eyes, skin, and lungs. Fumes can cause headaches, nausea, respiratory problems, muscle weakness, and liver and kidney damage. Some paints are flammable.

What You Can Do
Paint items outdoors when possible. When you paint indoors, make certain you have adequate ventilation. Using latex paints eliminates the need to use paint thinners which contain additional hazardous chemicals.

Product

Hobby Materials
    Glues & epoxies

Health Effects

Glues and epoxies are flammable. They irritate the skin and lungs and can make you more sensitive to a number of other substances. Some people have died after deliberately inhaling fumes from these products.

What You Can Do

Read product labels carefully. Wear gloves when you use them, and make certain you have good ventilation. Store these products away from heat and children.

Product

Photography Supplies

Health Effects

Dangerous chemicals used to develop photographs are methanol, xylol, methylene chloride, turpentine, benzene, acetates, and hydrocholoric acid. Methylene chloride and benzene have been associated with causing cancer. Many of these chemicals are flammable and can cause skin, eye, and lung irritations; some contain acids which can burn and blind you.

What You Can Do

Use these materials only in a well-ventilated area. Wear goggles and gloves. Store these chemicals in unbreakable containers away from heat. Store acids in non-metal containers. Never mix water into acid; when necessary, add acid slowly to water. Avoid products that contain benzene.

Products

Rug and Upholstery Cleaners

Health Effects

These cleaners may contain chemicals which, when inhaled, can cause nausea, anemia, liver damage, convulsions, and possibly coma.

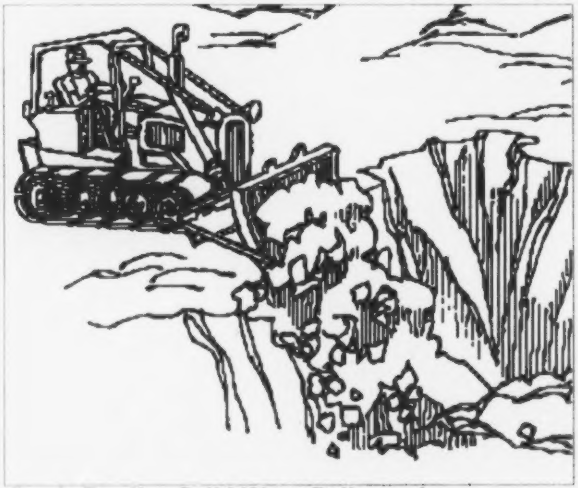
What You Can Do

Wear gloves and have adequate ventilation during the cleaning process. Clean rugs and upholstery with a non-aerosol shampoo. Check labels and purchase less hazardous products.

A Trip to a Landfill

Preparation Time: Easy To Do Moderate **Extensive**

Grade: 6 – 8
Focus: Solid waste disposal in landfills
Subject: Social Studies, Science
Materials: This lesson is a field trip exercise
Teaching Time: One class period plus field trip
Vocabulary: Landfill, leachate, RCRA, Superfund



Learning Objective
Students will:

- see, first hand, how a landfill operates
- examine the differences between a dump and a modern, sanitary landfill.

Background
For more information on landfills, see the Resource section.

In 1979 the U.S. Environmental Protection Agency issued landfill criteria that prohibited open dumping. According to the *Garbage Primer*, published by the League of Women Voters: "Concern about ground water pollution and other negative impacts of landfilling waste led to public opposition to local dumps and prompted the transformation of dumps into modern, sanitary landfills. Instead of communities hauling their garbage to the local ravine, sand pile, or old quarry at low or no cost, they are hauling it to high-priced modern landfills designed to protect the environment and the public.

South Carolina has 39 municipal solid waste landfills and, according to the *1993 Information Please Environmental Almanac*, South Carolina landfills about 80 percent of all of its garbage. The South Carolina Solid Waste Policy and Management Act of 1991 has banned many wastes from landfills. These wastes include yard trash, lead-acid batteries, whole waste tires, and used oil. White goods (refrigerators, stoves, etc.), are banned from South Carolina's landfills beginning in May 1994. According to the Department of Health and Environmental Control, about one-third of South Carolina's domestic waste permitted landfills will close in 1994.

The Act also requires the installation of scales at each municipal solid waste disposal facility and the keeping of records concerning all facets of solid waste management.

Stricter federal landfill standards under the Resource Conservation and Recovery Act (RCRA) have forced many small, local landfills to close. They have been replaced with larger local and regional landfills.

The reason landfilling garbage remains popular is that landfills are "cheaper to operate per ton of

DOWN TO EARTH

Only 16 percent of Japan's waste is disposed in landfills.

Source: Hershkowitz and Salerni

waste than either incinerators or recycling plants," according to the *1994 Information Please Environmental Almanac*. "The average price to landfill garbage, according to an April 1993 national survey of 3,000 landfills, was $34.38 per ton. However, start-up costs for a landfill built to conform with federal rules effective (in the fall 1993) are becoming more expensive, costing as much as $125 million."

Beyond coming up with the millions of dollars necessary to build a landfill, communities are faced with difficult decision of where to put the landfill. "The siting of new landfills is hampered by the poor environmental track record of older dumps," according to the *Garbage Primer*. "More than 20 percent of the 1,200 clean-up cites on the Superfund national priority list are garbage dumps."

RCRA's Subtitle D restricts the siting of landfills in floodplanes, wetlands, earthquake-prone areas, near airports, or where the ground cannot support the weight of a landfill. State and local governments can influence the selection of a site by requiring building permits, regulating the landfill size, and enforcing local zoning ordinances.

Modern landfills began as a hole dug in the ground. Today, sanitary landfills are lined with a layer of compacted soil, with a synthetic liner, or both. Garbage is dumped into this lined landfill cell and, at the end of each day, covered with a layer of soil or plastic. To ensure better pollution control, landfill regulations require that all new and expanded landfills be constructed with a liner, a leachate collection system (a system for collecting the fluids that seep through the garbage), a landfill gas control system (methane gas is generated in a landfill and collected through a system of pipes), and a ground water monitoring system. Subtitle D requires that when a landfill is full, it must be closed (capped with soil), monitored, and cared for for at least 30 years after closure.

According to the *Garbage Primer*, of the landfills in operation in the United States, fewer than 1,500 have ground water monitoring systems and only about 900 have liners.

Learning Procedure

1. Contact your regional Department of Health and Environmental Control Environmental Quality Control office to arrange a tour of the local landfill. You can find the list of regional offices included with this lesson and in the Resource section.

2. Review the Background material included with this lesson and this curriculum's Resource section on landfills with the class. Before the tour distribute (or prepare a transparency of) the graphic entitled *Layers of the Landfill* included with this lesson.

3. In preparation for their trip to the landfill, have students develop a list of questions to ask during the tour. As a class, consider questions in the following categories: technical, social, and regulatory. For example: technical questions may include:

- Design of the landfill. Is it lined? Does it have a leachate collection system? Ground water monitoring? Methane gas collection system? If so, what happen to the methane after it is collected? How many cells are there and how much trash is put into each cell? What do you use to cover the cells and how often? What kind of equipment do you use? What is the collection method? Is the waste compacted before it gets to the landfill? Where is this done?

Social questions may include:

- When was the landfill built? How was the site chosen? Was there any opposition to it being built here? How much time is left until this landfill is full? How much trash do you get each day? How many people work here? What are their jobs? How much does to cost to run a landfill?Are there plans to build a new landfill? When? Where? How much will it cost? Who will pay for this? Is there a charge to put garbage here? How much? What geographic area does the landfill serve?

Regulatory questions may include:

- Do you weigh the garbage before it is put into the landfill? How do you keep banned items, such as old tires, lead-acid batteries, yard wastes, and white goods, from being disposed in the landfill? Are there any local ordinances that affect

South Carolina Department of Environmental Control
Bureau of Solid Waste and Hazardous Waste Management
Division of Solid Waste Management
Environmental Quality Control District Offices

Appalachia I District - EQC
2404 N. Main Street
Anderson, S.C. 29621
(803) 260-5569, Fax 260-4855

Appalachia II District - EQC
301 University Ridge, Suite 5800
Greenville, S.C. 29601
(803) 241-1090, Fax 241-1092

Appalachia III District - EQC
P 0 Box 8778
975-C North Church Street
Spartanburg, S.C. 29303
(803) 596-3800, Fax 596-2136

Catawba District - EQC
2475 DHEC Road
Lancaster, S.C. 29720
Mailing Address: P 0 Box 100
Fort Lawn, S.C. 29714
(803) 285-7461, Fax 285-5594

Central Midlands District - EQC
Building #5/PO Box 156
State Park, S.C. 29147
(803) 935-7015, Fax 935-6724

Low Country District - EQC
1313 Thirteenth Street
Port Royal, S.C. 29935
(803) 522-9097, Fax 522-8463

Lower Savannah District - EQC
218 Beaufort Street, NE
Aiken, S.C. 29801
(803) 641-7670, Fax 641-7675

Pee Dee District - EQC
145 E. Cheves Street
Florence, S.C. 29506
(803) 661-4825, Fax 661-4858

Trident District - EQC
2470 Air Park Road
North Charleston, S.C. 29418
(803) 740-1590, Fax 740-1595

Upper Savannah District - EQC
613 South Main Street
Greenwood, S.C. 29646
(803) 223-0333, Fax 223-6935

Waccamaw District - EQC
1705 Oak Street Plaza/Suite #2
Myrtle Beach, S.C. 29577
(803) 448-1902, Fax 946-9390

Wateree District - EQC
105 Magnolia Street
Sumter, S.C. 29151
(803) 778-1531 & (803) 778-6548, Fax 773-6366

Layers of the Landfill

Today's sanitary landfill is engineered to protect public health and the environment.

Subtitle D of the Resource Conservation and Recovery Act establishes standards that municipal landfills must meet. A Subtitle D Landfill is layered like this ↘

Top Cap - The top cap of a landfill must be covered with:

- 2 ft. (61cm) thick soil cover
- Drainage layer
- Flexible membrane layer of 60 mil HDPE plastic*
- 18 inches (45.7 cm) minimum clay liner (1 x 10^{-5} cm/sec max)
- Gas management layer

Waste Cells with operational cover

Bottom Liner - The landfill must have a protective bottom liner system that includes:

- 2 ft. (61cm) protective layer of soil
- Leachate collection system
- Flexible membrane liner (60 mil HDPE plastic*)
- 2 ft. (61cm) clay liner (1 x 10^{-7} cm/sec**)

South Carolina ...

- Landfills about 80 percent of its solid waste.
- Has 39 permitted municipal solid waste landfills.

* Other, similar materials may be substituted for HDPE.

** Refers to the permeability, or speed in which liquids can seep, of the clay. This number means that liquids seep very slowly or hardly at all.

Tin Can Incinerator

Preparation Time: Easy-To-Do Moderate **Extensive**

Grade: 6 – 8
Focus: Solid waste incineration
Subject: Science, Math
Materials: See list below
Teaching Time: One to two class periods
Vocabulary: Volume, ash, incineration

Learning Objective

Students will:

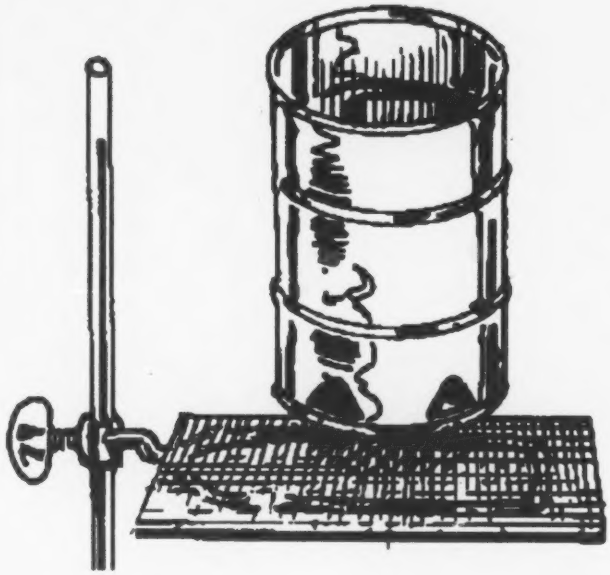
- calculate the reduction in weight and volume of solid waste from burning.

Background

This activity illustrates the volume and weight reduction possible through burning waste. It also illustrates that burning produces air emissions, *but does not simulate the operation of a state-of-the-art incinerator*. While backyard burning allows pollutants to escape into the atmosphere, today's incinerators capture about 99 percent of these emissions. Therefore, weight and volume reductions will be more dramatic in this experiment than in an incinerator. (See the Resource section for more information on Incineration.)

SAFETY NOTE TO TEACHERS:

1. Do not burn any types of plastics. It is impossible to tell what types of resins and/or additives are used in the hundreds of different plastic packaging. Many plastics such as PVC, polypropylene, or polystyrene produce toxins when burned.
2. Perform this experiment outside if your school does not have laboratory facilities for burning. Also it's a good idea to have a fire extinguisher or fire blanket handy.



Materials

- one-gallon metal can with several ventilation holes about one-inch from bottom. Use a punch-type can opener to make the holes
- a piece of metal screen large enough to cover the top of the can
- five pieces of cardboard, six-inches square
- masking tape OR us a pre-made box (like a shoe box) and measure the dimensions to calculate the volume
- enough solid waste to fill a box 6" x 6" x 6" (15 cm x 15 cm x 15 cm)
- materials that are easy to ignite such as paper, popsicle sticks, kindling, etc.
- matches
- ruler and balance
- marker
- safety goggles
- student work sheet (one per student)
- tongs

DOWN TO EARTH

South Carolina has an incineration rate of 5 percent. The District of Columbia has the the highest incineration rate at 59 percent.

Source: The Information Please Environmental Almanac, 1994

Learning Procedure

1. Distribute student worksheets and explain that in this lesson they will be burning representative waste items to observe the effects of **incineration**. Tape cardboard pieces together to form a box with four sides and a bottom. Fill the box with the waste, and have students calculate the **volume**.

Volume of waste = length x width x height (depth)
Volume of waste = 6" x 6" x 6"
(15 cm x 15 cm x 15 cm)
Volume of waste = 216 cubic inches
(3,375 cubic cm)

If you are using a pre-made box (like a shoe box), measure and calculate the volume.

2. Transfer the waste from the cardboard box to the gallon can. DO NOT BURN THE CARDBOARD BOX. Light the materials and immediately cover the top of the can with the screen. Observe what comes out of the can while the materials are burning. Have students record their observations in the appropriate area on the worksheet for future discussion.

3. When burning is complete and the **ashes** have cooled, return the ashes to the cardboard box. Spread them evenly on the bottom of the box and measure the height (depth) of the ash layer. Using the same formulas above, calculate the volume of the ash. Now, calculate the difference in the volume occupied by the waste before and after burning.

Extension Activities

1. Try incinerating an equal volume of food scraps (orange or banana peels, egg shells, apple cores, etc. You may want to dry these out so they will burn more easily.) Which is easier to burn: the food scraps or the paper and wood products from the original experiment? Which would take longer to incinerate? Are the final by-products from both experiments the same?

2. The classroom experiment allowed some ash, heat, and other by-products of burning to escape into the atmosphere. However, incinerators are required by law to have precipitators to remove ash and toxics from air emissions. Research different methods of pollution control in incinerators. What happens to the ash that is collected after incineration is complete? *(South Carolina has two landfills specially designed to accept ash. These are called "ash monofills," and are the Sandy Pines landfill located in Dorchester County and Bees Ferry landfill in Charleston County.)*

Just Do It

Help stop backyard burning in your community. Write articles for your school paper educating students about how backyard burning pollutes our air.

STUDENT WORKSHEET

Name ____ Date ______________

Step 1. Crumple the pieces of paper and put them into the can, packing them together to fill up as much space a possible. Fill the can with paper until it is about half full.

Step 2. Calculate the volume of the paper in the can using the following formula: $\mathbf{V = \pi r^2 h}$;
where $\pi = 3.14$, **r** = the radius of the can, **h** = the height of the paper in the can.
To find the height of the paper in the can, mark on the outside of the can with a marker the height of the paper, then measure with the ruler from the bottom of the can to the mark. Once you have completed your measurements, fill in the blanks below and perform the calculations. Your answer will be the volume of the paper and should be recorded on Chart #1. Show your work.

$\mathbf{V = \pi r^2 h}$
V = 3.14 x (r x r) x h
V = 3.14 x (______ x ______) x ______
V = ______

Step 3. Weigh the can and the paper on the balance. Record the weight on chart #2.

Step 4. Fluff the paper so that it is not packed too tightly in the can. Be sure to fluff the paper all the way to the bottom so that oxygen can get to all of the paper or it will not burn completely.

Step 5. Carefully light the paper with a match. DO NOT PUT THE MATCH INTO THE CAN.

Step 6. Observe what comes out of the can while the materials are burning. Record this on Chart #3.

Step 7. When the can has cooled, use the tongs to move the can and its contents to the balance. Record its weight on Chart #2.

Step 8. Calculate the volume of the ashes. Remember to mark the outside of the height of the ashes on the outside of the can and measure from the bottom of the can to that point. Your answer will be the volume of the ash and should be recorded on Chart #1. Show your work.

$\mathbf{V = \pi r^2 h}$
V = 3.14 x (r x r) x h
V = 3.14 x (______ x ______) x ______
V = ______

Step 9. Clean up your work area and follow your teacher's instructions for completing the charts and calculating the percent reduction in weight and volume of the waste.

Name ______________________________ Date ______________

Chart #1: Volume

A Volume of waste in can before burning $V = \pi r^2 h$	**B** Volume of ash in can after burning $V = \pi r^2 h$	**C** Difference in volumes (A-B)	**D** Divide C by A	**E** Multiply D x 100 (This is the (percent decrease in volume.)

Chart #2: Weight

F Weight of can and paper	**G** Weight of can and ashes	**H** Difference in weights (F-G)	**I** Divide H by F	**J** Multiply I x 100 (This is the (percent decrease in weight.)

Observations while burning: ____

____

____

____

____

____

____

____

____

Conclusions

From your observations and experiment, you should be able to make some conclusions about incineration and volume reduction of waste. What are your conclusions? Compare an open burning scenario, like the one you just completed, to that of a controlled incinerator where air emissions are monitored and most ash particles are removed. Compare and contrast the impact of open burning and incineration. Use a separate piece of paper.

Investigating Incineration

Preparation Time: **Easy-To-Do** Moderate Extensive

Grade: 6 – 8
Focus: Waste incineration
Subject: Science, Social Studies, Language Arts
Materials: Handouts included with this lesson, a bag of mixed trash (paper, plastic, glass, etc.)
Teaching Time: Two class periods, field trip
Vocabulary: Incineration, dioxin, ash, heavy metals, waste-to-energy, emission, toxic, hazardous waste

Learning Objective

Students will:

- consider the advantages and disadvantages of waste incineration.

U.S. EPA's Hierarchy of Waste Management Strategies

- Reduce waste by preventing its creation
- Recycle and compost as much waste as possible
- Incinerate waste or treat it in other ways to reduce its volume
- Landfilling waste is last in the list of options

Background

About 200 pounds (91 kg) of trash are generated each week by the average American family. More space is needed for waste disposal as landfills fill up and become more expensive and difficult to construct. **Incineration** is one possibility some experts consider.

Incineration reduces the volume of waste requiring disposal by 70 to 90 percent. In a **waste-to-energy** plant, burning waste can also generate electricity. At some incinerator sites, there is concern that **toxic** substances such as **dioxin** may be released into the air, creating air pollution and possible health hazards. Dust and noise pollution are other possible problems associated with incineration.

Incineration is most efficient when certain materials are separated out of the waste stream. Newspapers may raise the burning temperature too high for efficient burning, and they pollute the **ash** with **heavy metals**. Metals and glass do not burn.

Because newspaper, steel, aluminum and glass are all recyclable, separating these materials from the waste stream prior to incineration contributes to resource conservation and efficient plant operation.

Although waste combustion is listed in the U.S. EPA's Integrated Waste Management strategy before landfilling, incineration is a waste management method that sparks controversy among scientists and citizens.

In South Carolina, incineration is not listed as a priority over landfilling. However, as counties develop their waste management plans, incineration is an option. Specifically, as stated in the 1992 South Carolina Solid Waste Management Plan, "With the increased cost of converting existing landfills and the high costs of siting and

DOWN TO EARTH

France was the first nation to impose a direct pollution tax that requires emitters to pay per unit of pollution discharged.

Source: 1993 Environmental Almanac

constructing new landfills to comply with the new federally mandated standards, it is essential to adopt the most effective volume reduction techniques. Each county/region must consider all options and must select the best available volume reduction methods for its integrated solid waste management program.

"Nearly 75 percent of the municipal solid waste stream is combustible. Therefore, combustion provides the greatest degree of volume reduction, 70 to 90 percent. A county/region with a large concentrated population should consider a waste-to-energy, or combustion system as part of the volume reduction efforts of its integrated solid waste program."

The pros and cons of incineration need to be weighed by people looking for solutions for solid waste disposal and pollution. There are no right or wrong answers, only informed opinions. For more information, see the incineration handout included with this lesson and the information in the Resource section.

Learning Procedure

1. Hold up the bag of mixed trash. **Ask:** Not know what's in this bag, do you think it would be better to incinerate it or bury it in a landfill? (Let students brainstorm their answers.) Have several students sort it for items that could be reused or recycled, removing them from the waste stream. Compare the amount left to the original sampling. Discuss the implications of incinerating or landfilling our natural resources versus recycling them.

2. Share the Background material in this lesson, the illustration of an incinerator, and in the Resource section in Incineration, and discuss with the students the pros and cons of incineration.

3. Give each student a copy of the handout material. Assign students to read the material and to prepare one of the following projects to be presented to the class:

- write and present to the class a 60-second television public service announcement supporting/opposing incineration. (Let each student decide their own position) Draw one scene from the storyboard.
- create an informational poster on incineration
- research and write a list of 20 facts about incineration from at least two sources different from the handouts
- write a letter to your county waste management supervisor stating your opinion for or against incineration
- using the *Inner Workings of an Incinerator* illustration, invent a new technique for improving incineration. Write a paragraph about how your invention would work and how it will make the environment cleaner. (Students may draw a diagram of their invention.)

4. From the class discussion, develop a list of questions and write to a waste incineration plant operator. Questions could address treatment of ash, scrubber technology, and types and sources of waste incinerated. Call S.C. DHEC at 1-800-76-USE-IT for the location and address of South Carolina's incinerators.

Extension Activities

1. Take a field trip to a commercial incinerator.

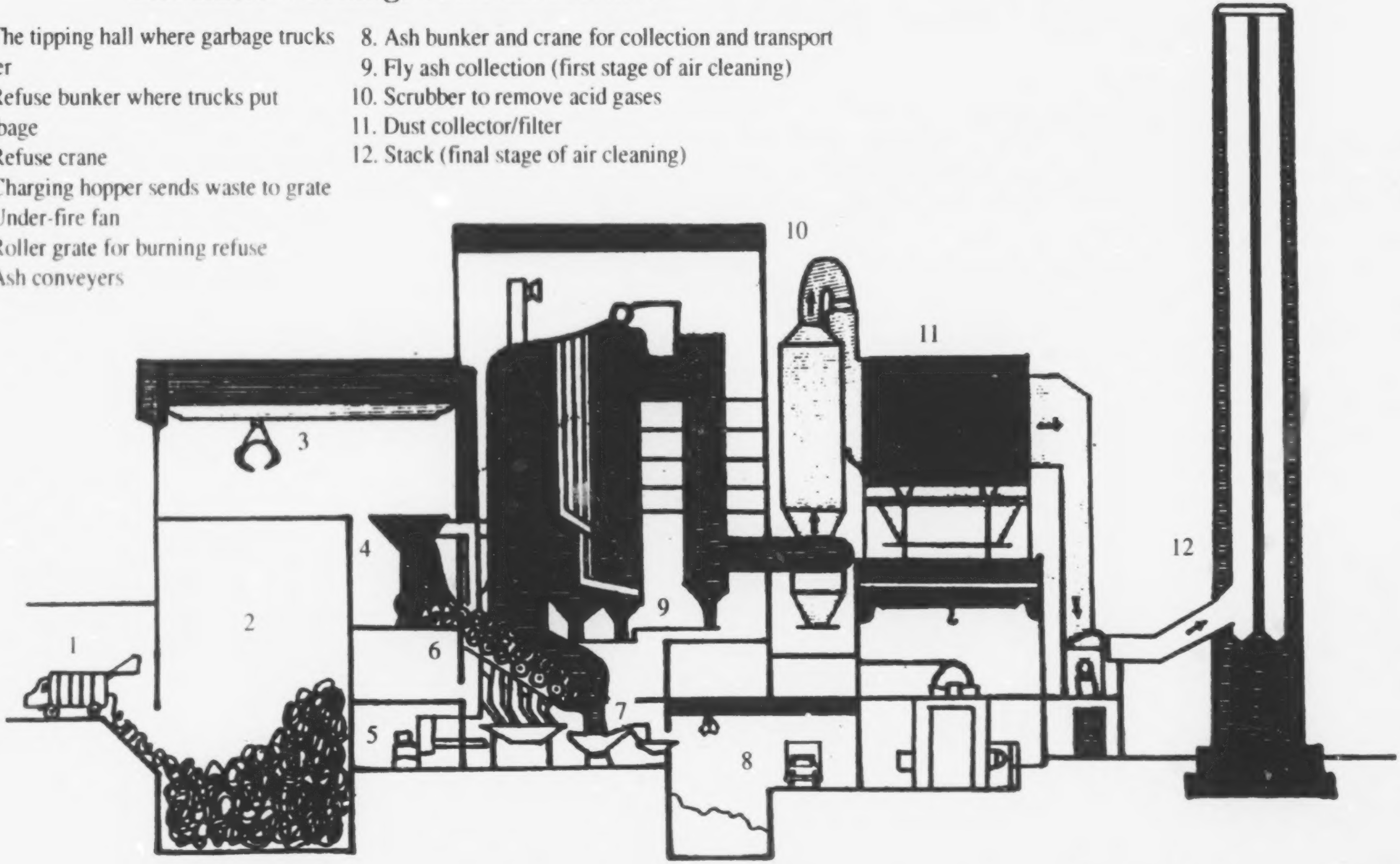
2. Construct a wall chart comparing the advantages and disadvantages of waste incineration.

Just Do It

Never burn wastes, including yard clippings and leaves, at home. Backyard burning does not have the pollution prevention technology needed to safely deal with trash.

The Inner-workings of an Incinerator

1. The tipping hall where garbage trucks enter
2. Refuse bunker where trucks put garbage
3. Refuse crane
4. Charging hopper sends waste to grate
5. Under-fire fan
6. Roller grate for burning refuse
7. Ash conveyers
8. Ash bunker and crane for collection and transport
9. Fly ash collection (first stage of air cleaning)
10. Scrubber to remove acid gases
11. Dust collector/filter
12. Stack (final stage of air cleaning)



The History of Incineration

The first municipal incinerator was designed and built in England more than a century ago. It seemed to be a simple, efficient and sanitary way to dispose of garbage. Burning garbage eliminated the need for transporting waste from cities, saved space in dumps and destroyed many disease-causing microorganisms and viruses. The technology was soon imported to this country, and by the 1920s there were more than 300 incinerators in use.

The first incinerators burned trash without worrying about what was coming out of their smokestacks. As concern rose over the quality of our air and legislation was introduced to prevent further air pollution. the cost of pollution control equipment made it cheaper to landfill waste and use of incinerators declined.

Technology was then developed to absorb some of the heat from waste incineration, turning water to steam which could then be used to generate electricity. This process lowered the temperature of incinerator exhaust to within temperatures where proven emission control equipment could operate effectively. This technology made it possible to install pollution control equipment in incinerators. An incinerator's ability to generate electric power helped offset some of the high cost of installing this emission **scrubbing** equipment. With landfills filling up, this new technology, called with varying degrees of precision "waste-to-energy," "energy recovery," and "resource recovery," led to a renewal in incinerator popularity in the 1970s.

Today's waste-to-energy incinerator plants can reduce up to 90 percent of the volume of waste needing to be disposed and can be designed to process from 100 to more than 3,000 tons of refuse daily. At the same time, they produce steam or electricity which can satisfy a portion of local energy needs.

How Do Incinerators Work?

Incinerators burn waste to reduce its volume; that is, to make it smaller. Incinerators can burn unprocessed waste (that is trucks just dump garbage into the tipping hall; this called "mass burn.") or processed waste (that garbage that has had materials that do not burn ... such as glass and metal ... removed; this is called "refuse-derived fuel"). Incinerators can be equipped to generate energy by using the heat from burning garbage to turn water to steam, which is then either fed into a steam-loop (sometimes called a district heating system) or used to turn turbines installed at the incinerator plant to generate electricity.

Mass-burn facilities appear convenient from a solid waste management perspective. There is no pre-processing of waste, and no changes must be made in the way most cities and towns collect their trash. When trucks enter a mass-burn facility, their loads are weighed, and the trash is delivered to a tipping platform. Front-end loaders and cranes are used to push the waste down a shoot (hopper), from where it is fed into the combustion chamber. The residual ash from the combustion chamber (bottom ash) and ash collected by pollution control equipment (fly ash) is deposited into large covered dumpsters which are hauled away to a lined landfill.

Incinerators require a steady flow of waste and need to maintain a steady temperature in burning. Non-combustibles in the waste stream such as glass and metal inhibit efficient burning as do kitchen wastes, leaves, and grass because of their high moisture content (30-75 percent water) and low Btu (or heat released during combustion) value. Increasing amounts of petroleum-based plastic, with a high Btu value, in the waste stream also affect burning. To maintain a consistent temperature, incinerator operators must control the type of garbage, the amount of trash fed into the plant, how often the system is started up and shut down, and other variables that change burning temperatures.

What Are Some Of The Benefits Of Incinerators?

Incinerating solid waste can reduce the volume of trash going to a landfill by up to 90 percent, resulting in a 60 to 70 percent reduction overall in landfill demand. And that means that landfills do not fill up as fast. By doing, this incineration helps conserve land and protect water sources from contamination.

Incineration also destroys potentially disease-causing organisms in solid waste and helps keep them out of landfills. Incineration also destroys a number of chemicals and toxic compounds, such as pesticides, that are a major source of contamination at existing landfills. Dioxins are both created and destroyed in the incinerator combustion process, and some data indicate that resulting dioxin levels may be reduced overall from that found in incoming solid waste.

In waste-to-energy plants, heat from the combustion process is used to make electricity. While the sale of this electricity is not enough to pay for the incinerator, it does help defray some of the expense.

In many countries, incineration is the primary waste disposal solution. In Japan, where about 50 percent of waste is recycled, 34 percent is incinerated. Incineration is beneficial because Japan has a growing population and very little land available for landfills. In the past 25 years, Japan has build more than 1,900 incinerators and many of these are waste-to-energy facilities … burning garbage and making electricity.

What Are Some Of The Problems Of Incinerators?

Incinerators share many of the problems of any waste management facility such as landfills and recycling centers. These shared problems include truck traffic and associated noise and litter. However, since operations take place within an enclosed structure at an incinerator, problems such as litter, odors, and insect and rodent infestation are better controlled than at a landfill. The by-products of incineration

— ash, gases, and heat — can be collected and reused to a large extent. And while incineration is a highly efficient method of waste disposal, there is some concern over the remaining by-products that cannot be reused.

Generally, the most controversial by-product is ash collected from scrubbers designed to take impurities out of the smokestack. According to *The Garbage Primer* from the League of Women Voters, an incinerator that burns 1,000 tons of trash per day can generate between 200 and 250 tons of ash a day as a residue. The composition and toxicity of this ash depends on the content of the waste burned and the efficiency of combustion. It must be specially treated as a hazardous waste and disposed in a special landfill.

Incinerators are expensive to build, operate, and maintain, making it most economical to build large plants so that cost-per-ton-of-waste accepted are lower. However, large sums of money must be borrowed to construct an incinerator, and whether the plant is running at half or full capacity, the agreed upon schedule of payments must be met. Therefore, although larger plants may be more economical, oversizing a plant can be very expensive and actually can create something of a "demand" for waste, something contrary to waste management goals. Facilities are perhaps best undersized but designed with space to add an additional incinerator unit should it be needed.

6.III.1.F

When They're Gone, They're Gone

Preparation Time: Easy-To-Do Moderate **Extensive**

Grade: 6 - 8
Focus: Natural resources and wasteful use
Subject: Social Studies, Science
Materials: See list below
Teaching Time: Two class periods
Vocabulary: Natural resources, renewable and nonrenewable, sanitary landfill, recycle

Learning Objective

Students will:

- determine the difference between renewable and nonrenewable resources
- identify the problems of landfilling waste
- investigate options for saving nonrenewable resources
- explore the distribution of natural resources around the world.

Background

As countries become more industrialized and developed, they consume more natural resources. These natural resources may or may not come from the developed country. Most developed countries buy and import natural resources from other countries. For example, the United States is the world's top consumer of energy and a major consumer of natural resources. It ranks first or second in consumption of nine metals. One U.S. citizen consumes more than five times the world average of commercial energy supplies and even higher level of many other natural resources.

Natural resources are sources of material wealth within a country, such as timber, fresh water, or naturally occurring mineral deposits such as iron, gold, bauxite, etc. A **renewable resource** is a natural resource that can be regenerated by natural ecological cycles or sound management practices. Timber and water generally fall into this category.

Nonrenewable resources are materials that are finite in number and cannot be regenerated. Petroleum and many mineral deposits are typical nonrenewable resources.

Learning Procedure

In this lesson, students will simulate the accumulation and consumption of the earth's natural resources. They will then discuss the problems arising from the unequal and wasteful use of natural resources.

DOWN TO EARTH

According to the United States Energy Information Agency, petroleum accounts for about 40 percent, natural gas 23 percent and coal 22 percent of the resources used to produce energy in the United States.

Source: 1993 Environmental Almanac

Materials

- 2# coffee can (or a bag)
- buttons, craft beads, small pieces of construction paper or candies in the following colors and quantities:

red	400
blue	104
green	12
orange	1
yellow	1
purple	1
clear	1

- 6 cups
- writing materials

Learning Procedure

1. Discuss the background material provided in this lesson.

2. As a class make a list of renewable and nonrenewable resources on the board. Explain that the beads (or similar material selected) represent nonrenewable resources. The number of beads reflect a mineral's relative estimated total of abundance, *not* the ease with which it can be obtained. Tell the students that these beads will be used in an activity later in the day.

3. Reproduce the chart, included, on the board.

4. Hide the beads throughout the classroom when the students are out of the room. Be sure to hide some in easy-to-find places and others in more difficult places.

5. Divide students into teams representing countries. To show increased potential in exploring for and money available to buy resources, vary the size of each group. (USA 6, Russia 6, Europe 4, Japan 3, Canada 2, Zambia 1)

6. Give the teams time to explore for resources (beads). Have them collect beads in the plastic cups. First, give the students two minutes to search around the room and then return to their group. Repeat the search a second time, but this time for only one minute.

After each exploration, students should separate and consider their results based on the beads they have gathered in their cups.

7. Discuss the greater difficulty in finding resources during the second exploration time. (*Competition becomes more intense for fewer resources.*) Discuss real-life examples of countries competing for resources. *(For example, wars in the Middle East over control of petroleum reserves.)*

8. Beads in the cups represent natural resources that are manufactured into produces, used, and eventually discarded. Some natural resources are used for many years, while other natural resources are used for a very short time and end up in the waste stream.

9. Explain that much of what is thrown away is recyclable. Discuss the the wastefulness of throwing natural resources into a landfill.

10. **Ask:** What can we do to extend the life of nonrenewable resources? (*Recycle.*) What are the advantages of extending the life of resources? *(More resources are available in the future, there may be fewer international conflicts, etc.)*

Questions for the Class

1. What will happen to the resources in the reserves if we continue this process? *(We will eventually run out; there may be conflicts with the more technologically advanced continents "winning;" more powerful continents may try to gain the resources of less powerful continents through trade, aggression, etc.)*

2. What can be done to stop wasting these resources? Make a list. Examples: recycle whenever possible, use less energy *(It takes less energy to recycle than to produce new products from raw materials.)*, reduce unnecessary packaging.

3. How did you feel about the unequal accessibility of the resources? Discuss the "fairness" of the situation.

4. How did you feel about returning the resources to the can so they could be used again?

5. How much longer could we extend the process if we recycle? What will happen if the population increases? Will it become more necessary to recycle?

6. Should the development of renewable energy sources (solar, wind, geothermal) be increased because of the finite status of coal, natural gas and petroleum?

7. Ask these a few days after this exercise:

- Did you use a product made from a renewable resource today? If yes, what? What did you do with the product when you were through with it?
- Did you use a product made from a nonrenewable resource today? If yes, what? What did you do with the product when you were through with it?
- What can you do to conserve natural resources?

8. Discuss the future mining of sanitary landfills for natural resources.

Extension Activities

1. Research the nonrenewable resources represented by the beads in this lesson. What are the latest global reserve estimates and where are they found. *The U.S. Bureau of Mines produces a report entitled the Mineral Commodities. It can be obtained from the U.S. Department of the Interior in Avondale, Maryland.*

Develop and distribute "How to Recycle" information to the school administration, neighbors, local businesses, community centers, or the media.

2. Hold an all-school assembly complete with skits and talks given by the students about the importance of resource conservation.

3. Have students pick a country and research its natural resources. Write a paragraph describing imports, exports, and consumption.

Just Do It

Conserve resources at home. Mine valuable paper, glass, plastic, and aluminum in the trash and recycle it; conserve energy by turning off lights and turning down the heat and turning up the air conditioner; reduce your family's use of convenient "throw-away" products that turn resources into waste.

Distribution of Beads as the Earth's Resources

Color	Number of Beads	Finite Resource Represented
Red	400	Iron in Ore
Blue	104	Bauxite (aluminum ore)
Pink	31	Chromium
Green	12	Copper
Orange	1	Lead
Yellow	1	Tin
Purple	1	Silver
Clear	1	Platinum

Action for a cleaner tomorrow.

A South Carolina Environmental Curriculum

For more information about South Carolina and the environment. call the
South Carolina Department of Health and Environmental Control at
1-800-768-7348.

Fast Food Survey

Preparation Time: **Easy-To-Do** Moderate Extensive

Grade: 6 – 8

Focus: Excessive packaging in fast foods and convenience foods

Subject: Science, Social Studies, Math, English

Materials: See *Fast Food Survey* with this lesson

Teaching Time: Two class periods (Best to begin this on Friday) requires after school work

Vocabulary: Recyclable

Learning Objective

Students will:

- evaluate the trash generated by fast food restaurants and packaged convenience foods
- become aware of the frequently excessive packaging used in the fast food and convenience foods industries
- differentiate recyclable waste from non-recyclable waste.

Background

Kids love to spend their free time eating convenience foods and socializing at various fast food establishments. Some restaurants are known for the volume of non-recycled trash they generate. Others have made an all-out effort to help solve the problem.

It is essential to solving the solid waste dilemma in this country to reduce the amount of trash produced.

Many foods use packaging that is not, at present, readily **recyclable**.

Learning Procedure

Day 1

1. **Ask:** How many times per week do you eat at a fast food restaurant? (Determine the average number of visits per week for the class.) **Ask:** How much trash do you throw away from each visit? (With the class estimate the number of bags of trash per year.) **Ask:** Is all of this trash necessary?

2. Discuss the types of packaging used by various convenience foods and fast food restaurants. List these on the board. *(burger boxes; french fry sacks, bags, boxes and cups; single-serving plastic microwave containers, pizza boxes; etc.)* Discuss the purposes of the packaging *(stacking, warmth, sanitation, appearance, aesthetics, individual servings, advertising).*

3. Have the students define the word "recyclable."

4. Divide the students into groups of four. Have the groups divide the list of packaging types on the board into two categories: recyclable and non-recyclable. Then have the groups discuss the following

- Do fast food restaurants recycle their trash? (If they don't have special receptacle for recyclables in the restaurant, they probably aren't recycling.

According to the book, *50 Simple Things You Can Do To Save The Earth*, "it takes 1,630,000 gallons 6,170 kl of water to feed an American for a year."

Restaurant employees do not sort the trash for recyclables.)

- Why wouldn't a restaurant recycle? *(Time, money, health and cleanliness concerns, etc.)*
- Why would they? *(Good for public image, corporate conscience, etc.)*
- Do convenience foods generate excessive waste?

5. Instruct the students to visit (or recall a visit to) a fast food restaurant and complete the *Fast Food Survey*. Tell the students that their job is to observe the amount of trash and kinds of trash generated by a fast food restaurant. Each group member is to visit a different restaurant (or they can go in small groups). This will allow for a better overall survey. This activity can also be done with each group member recalling the packaging and trash generated from different fast food chains.

Day 2

1. After the students complete the survey, reconvene the group and have them discuss their surveys with other class members. Encourage them to give as much detail as possible about their visit. Compare trash/packaging on take-out orders to eat-in orders.

2. Using the formula on the work sheet, the groups are to determine the percentage of recyclable trash disposed of by the various restaurants. They then decide which restaurant, if any, seems most concerned with trash disposal and the environment and why.

3. Have the group consider what to do about trash disposal in food restaurants and suggest ways to remedy the problem. Are following ideas are feasible:

- Recycling bins for paper, plastic and aluminum
- Trash compacting
- Reduction in packages and wrappers.

Extension Activities

1. To demonstrate the volume of trash generated by fast food restaurants, have the students collect all the fast food trash they can for a day or a week Then have them sort the trash into recyclable and non-recyclable stacks. (Only clean trash, no food.)

3. Have a fast food restaurant manager come to your class to discuss what his or her restaurant is doing about waste generation and the environment.

4. Have the students write a letter to the president of their favorite fast food restaurant expressing their concerns about this problem. In the letter, they should state that they have observed the problem firsthand. Offer possible solutions.

5. Encourage students to:

- Ask for their food wrapped in paper only - not have their food bagged if it is only a few items
- Keep track of the volume and types of solid waste trash generated in preparing meals at home. What could they do to reduce the amount of waste generated through meal preparation at home? *(Recycling, picky purchasing, recycling at home)*
- Develop an article for your school newspaper reporting on the project.

6. Ask the students to consider what the phrase *Think Globally, Act Locally* means. Have them write a paragraph.

7. Write a proposal to the cafeteria manager or principal suggesting improvements that can be made regarding waste in the cafeteria.

Just Do It

For more information about minimizing
fast food trash, contact:
The Society of the Plastics Industry
1-800-243-5790

DO FAST FOODS EQUAL LONG-LASTING TRASH?

WORKSHEET

Name of Restaurant	Number of Menu Items	Types of Packaging Used (paper, plastic, etc.)	Uses Recycled Paper or Recycles Trash

In this activity you are asked to observe the types and amounts of packaging/trash generated by fast food restaurants. Keep alert for the recycled paper symbol. This is a big plus for the restaurant. Take good notes on what you observed because you will report your findings to your group.

Do any restaurants offer any types of recycling options? What are those options?

To determine the percentage of packaging items that are recyclable, use the following formula:

$$\frac{\text{recyclable packaging}}{\text{\# of items on menu}} \times 100$$

Hint: Recyclable packaging includes all paper, plastic, straws and cups, clear wrap, aluminum, and glass products.

Action
for a
cleaner tomorrow.

A South Carolina Environmental Curriculum

For more information about South Carolina and the environment. call the
South Carolina Department of Health and Environmental Control at
1-800-768-7348.

Oil & Water

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 6 – 8
Focus: How oil pollutes water
Subject: Science, Social Studies
Materials: See list of materials itemized below
Teaching Time: Two class periods
Vocabulary: Dilute, photosynthesis, carcinogens, plankton

Learning Objective

Students will:

- see how oil pollutes water
- test water samples for the presence of oil
- perform an experiment to determine one part per million.

Materials

If possible, assemble several sets of these materials so that the class can perform the experiment in small groups, otherwise use one set of materials and perform the experiment as a class. One set of materials includes: seven test tubes (OPTION: seven same-sized jars, such as baby food jars), test tube rack, 10 ml graduated cylinder, olive oil, 250 ml beaker, brown paper bag (cut in strips), blue food coloring, wax pencil, eye dropper (or calibrated straw).

Background

Have you ever heard the saying, "Oil and water don't mix?" Oil in any form can have an affect on our environment. Some studies have shown that after a shoreline spill, it may take up to 20 years for the environment to return to its original condition. (For more information, see the Resource section on Used Oil.)

When oil ends up in water, a film of oil on the surface can block **photosynthesis** and slow the production of oxygen. The reduced oxygen supply then causes stress to the point of death in aquatic organisms. Large organisms such as mammals and birds are the most familiar victims of oil pollution because of their visibility and emotional appeal to people. Feathers and fur stick together, become matted and lose their ability to insulate animals against cold. Death may result from temperature shock or from ingesting (or eating) oil as the animals try to clean it from their coats.

Oil in water can also affect other organisms. Some of the components of oil may evaporate into the air or dissolve into the water. Many of the compounds are **carcinogens**. Some of the oil spilled into an aquatic environment settles to the bottom, affecting the organisms living there. Oil can clog breathing structures or be absorbed into tissue and then passed along the food chain, even to humans who eat fish or shellfish. Oil may

DOWN TO EARTH

There are more than 550 million motor vehicles operating worldwide, each of these vehicles averages three oil changes each year. The United States leads the world in the number of cars per capita. Africa and Asia, with three-fourths of the world's population, have only 12 percent of the world's cars.

harm bacteria or **plankton**, the basis of the food chain.

One gallon (3.8 liters) of used oil can potentially destroy 1 million gallons (3,785,000 liters) of fresh water – enough to supply 50 people with drinking water for an entire year. One pint (1/2 liter) of oil can produce a slick on water about one acre in size and will kill floating aquatic organisms.

The U.S. Coast Guard estimates that sewage treatment plants discharge twice as much oil into coastal waters as do tanker accidents. A major source of this pollution is from oil dumped by individuals into storm drains and sewers. Unfortunately, even a little used oil can go a long way in polluting soil, streams and lakes.

What Can We Do With Used Oil?

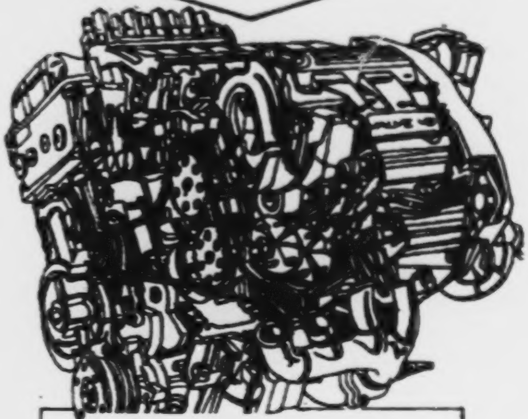
Recycling used motor oil makes good sense. It not only eliminates a health hazard and protects the environment, it also saves energy. All automotive oils can be recycled safely and productively and can be used again as a fuel, lubricant or other petroleum products.

While it takes 42 gallons (159 liters) of crude oil to produce 2 1/2 quarts (2.4 liters) of lubricating oil, only one gallon (3.8 liters) of used oil can be turned into the same 2 1/2 quarts (2.4 liters) of lubricating oil. And it's good quality oil, too. According to studies by the National Bureau of Standards, the Army, and the Department of Energy, re-refined oils perform as well as virgin oils. However, you should consult owners manual before using re-refined motor oil.

It's not just the oil that poses a threat to the environment. Many additives and contaminants help make used oil toxic. As much as 20 percent of automotive oil is composed of substances that are added to improve performance, inhibit rust or prevent foaming. Oil will also pick up sediment and gasoline components and additives from the engine during combustion. High levels of lead, as well as other toxics including benzene, cadmium, zinc, magnesium, and PCB's may be present in oil and may contaminate the environment if not properly handled.

Your car's motor oil ... coming and going

New motor oil contains:
pour point depressant;
detergent; foam, oxidation, rust
and corrosion inhibitors;
viscosity index improvers;
anti-wear additives



Used motor oil contains:
- all the original ingredients

PLUS
water and dirt, iron and
steel, copper, heavy metals
including lead, cadmium,
zinc, barium, sulfur, ash

Used oil should never be emptied into sewers or storm drains, or dumped directly onto the ground to kill weeds or to suppress dust on dirt roads. Also used oil should never be thrown into the trash where it will end up in landfills.

Learning Procedure

Day One

1. Review the background materials on the environmental affects of oil with the class.

2. Have students perform the following experiment to demonstrate how small quantities

of oil can pollute large amounts of water. Perform the experiment as follows:

a) Measure 100 ml of blue water into your 250 ml beaker.

b) Add 9 ml of blue water to each test tube in your test tube rack.

c) Calibrate the eyedropper to measure 1 ml. This can be done by adding 10 ml of this solution to your cylinder and then drawing out water, using the eyedropper, until the level in the cylinder reaches the 9 ml mark. Use the wax pencil to mark the water level in the dropper.

d) Pour out unused water from your cylinder and measure out 1 ml of olive oil. Add this to test tube #1.

e) Shake the test tube thoroughly. Quickly, before the oil and water separate, remove 1 ml of this solution with your calibrated dropper and add it to the next test tube (#2).

f) Repeat step e) until you feel that there is no oil left, checking either visually or by smell. Repeat step e) no further than test tube #7; at this point, you will have a dilution of one-one millionth.

g) Check for oil in your solution by dipping a strip of brown paper 5" (12.7 cm) long by 1/2" (1.3 cm) wide into the test tube. If you don't observe the oil immediately, label your strip and set it aside to dry overnight.

h) Clean up your lab area and materials. Use warm water and soap to remove all traces of oil in all the test tubes.

Day Two

3. Check the brown paper strips for oil spots.

4. Have students answer the Questions for the Class individually or as a group.

Questions for the Class

1. Did you find oil spots on the brown paper the next day? *(yes)*

2. Where do you think this oil would go in nature? *(It might end up in our lakes and rivers or in our ground water sources. It might be ingested by fish and animals and by people.)*

3. What are some of the contaminants found in used oil? *(Used oil contaminants include heavy metals such as lead, cadmium, zinc, barium, chemical additives, dirt, iron, and steel particles.)*

4. Did the water **dilute** the oil completely? *(no)*

5. List items you or your family own that use oil and have the capability of contaminating the environment. *(This list might include lawn mowers, cars, boats, gas powered tools such as chain saws, string trimmers and leaf blowers.)*

6. What can you do with used oil to prevent it from becoming a source of pollution? *(Take it to an oil recycling station such as the ones in the South Carolina Used Oil Partnership's program.)*

Extended Learning

1. Have students prepare posters promoting oil recycling and how to collect used oil for recycling. Ask local service stations and automotive stores to display them.

2. Have students investigate what your school district does with the used oil from school buses and other maintenance equipment. Have students calculate how much used oil your school district must handle during the school year. *(How many vehicles times how much oil per oil change times how many oil changes per year.)*

3. Have students research and prepare reports on how oil is recycled into energy in South Carolina.

Just Do It

Recycle used oil at one of the more than 250 used oil recycling centers across the state.
For more information on used oil recycling in South Carolina call, 1 800 76 USE IT.

Action for a cleaner tomorrow.

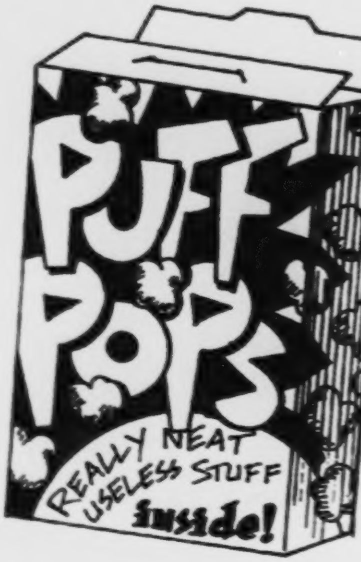
A South Carolina Environmental Curriculum

For more information about South Carolina and the environment, call the
South Carolina Department of Health and Environmental Control at
1-800-768-7348.

Where Did The Waste Problem Come From?

Preparation Time: Easy-To-Do [✓ **Moderate**] Extensive

Grade: 6 - 8
Focus: Consumerism, packaging waste
Subject: Social Studies
Materials: See list below
Teaching Time: One hour
Vocabulary: Recycling, packaging, advertising, renewable, nonrenewable, biodegradable, non-biodegradable



Leaning Objective

Students will:

- learn how our consumer-oriented lifestyles contribute to the problems of solid waste.

Background

Solid waste has increased more 50 percent, from 2.65 pounds (1.2 kg) per person per day in 1960 to about 5.6 pounds (2.52 kg) per person per day today in 1996. This increase can be attributed to a growing reliance on convenience items: convenient for use and for disposal. Along with this trend, of course, the population has increased as well. Between 1970 and 1986, the U.S. population increased by 18 percent but its trash output increased by 25 percent.

It is estimated that 33 to 40 percent of the solid waste generated in the United States is **packaging**, more than 44 million tons each year. Packaging is designed to protect its contents from physical damage and spoilage, and therefore, allows transportation of goods from far away, without adding broken or rotten products to the waste stream.

In the United States, it is estimated that only 12 percent of transported food spoils, while in the former Soviet Union, it is estimated that some 50 percent of transported food spoils.

Packaging not directly related to protecting products from breakage or spoilage is considered excessive by environmentalists. Much of this packaging is **advertising**, designed to help sell the product.

Packaging is made from a variety of materials, some recyclable or compostable, and some not. More and more, metal, glass and paper/cardboard materials ... all **recyclable** or **compostable** ... are being replaced by plastic or multi-type, multi-layered materials which are almost impossible or very expensive to recycle or compost.

Just how much does packaging cost? One dollar out of every $11 spent on food and beverages goes for packaging.

DOWN TO EARTH

Packaging labels are just beginning to be regulated in the United States. According to experts, the words "environmentally safe" or "environmentally friendly" are legally meaningless.

Materials

Collect a variety of consumer products that students can examine and discuss in class. (Option: Have students bring in samples of these products.) Try to find products that fit into several categories such as:

- single use items
- reusable items
- items that come in packages that may be reused
- high-convenience products (You may want to list alternatives.)

Product examples include:

- a package of chewing gum
- a complete pizza mix with crust, sauce, and cheese
- a complete cake mix
- a two-liter, plastic drink bottle
- a wrapped men's shirt
- a plastic ice cream tub
- a watercolor paint set
- an empty pickle jar
- disposable tableware
- a TV dinner
- a "snack" lunch product

Learning Procedure

1. Review the Background information and the related information in the Resource Section with the class.

2. Divide the class into groups and distribute the sample products.

3. Ask the students to open the products and examine the contents and packaging. What is the packaging made of? What is the packaging's function? Is it adequate/excessive? What is the best method of disposing of the packaging?

4. Ask the groups to report to the class about their particular product(s).

Questions for the Class

1. How many of these packages are a) reusable, b) recyclable/compostable or **biodegradable** (can recycling or composting be done locally?), c) excessive, d) made from a **renewable** or **nonrenewable resource**, or e) adequate and necessary for the protection and preservation of the product. NOTE: This list could be made into a chart for the group or classroom discussion.

2. How much trash would we have to throw away after we took out the recyclable or reusable materials?

3. Are there alternatives to packaging?

4. What effect would buying larger packages *(buying in bulk)* have on the amount of waste coming out of your home? What effect would it have on your individual lifestyle at home? *(storage space, ease/difficulty of use, higher up-front costs vs fewer trips to the grocery store, etc.)*

5. What effect does bulk packaging of products have on the retailer? *(You might want to discuss the physical differences between a grocery store and a warehouse-style, wholesale shoppers club.)*

Just Do It

Bigger is better when it comes to packaging of ordinary consumer goods. When you buy in bulk, you get more product and less packaging to throw away. Is your favorite product – like your breakfast cereal – available in recycled or recyclable packaging? If not, write the maker a letter and let them know you'd prefer it. Also, let your grocer know you are interested in bulk-sized packages. Or maybe you could change *your* lifestyle and get a new breakfast cereal.

Environmental Shopping

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 6 – 8

Focus: How to buy less waste, resource conservation, consumer awareness

Subject: Home Economics, Social Studies, Math

Materials: Student handouts included

Teaching Time: 45 minutes in addition to student time to conduct survey

Vocabulary: Renewable resources, nonrenewable resources, organic

Learning Objective

Students will:

- see how careful buying is the first step in solving our solid waste problem
- understand how recycled materials are used in packaging
- determine which natural resources are used in packaging and how these resources can be conserved through careful buying and recycling.

Background

According to "Realizing Recycling's Potential" by Cynthia Pollack-Shea, nearly $1 out of every $11 spent for food and beverages in the United States pays for packaging. The food packaging bill in a single year totals as much as $28 billion; this is more money for packaging than the farmers receive in income.

Many other consumer goods also suffer from over packaging.

Learning Procedure

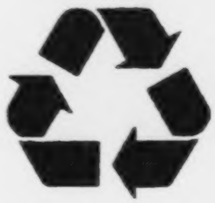
1. **Ask:** How can you reduce the amount of packaging you throw away? Encourage students to brainstorm their ideas.

2. Explain to students that they will be analyzing products and packaging in surveys that they will complete for homework. You may want to divide the class into small groups for this assignment.

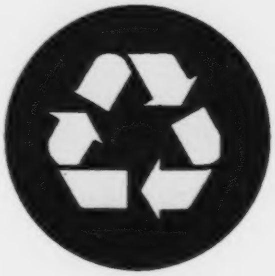
3. To complete these assignments, students must understand these terms:

- **Organic** - derived from living organisms
- **Renewable Resources** - naturally occurring raw materials derived from an endless or cyclical source such as the sun, wind, falling water, fish and trees. With careful management, the consumption of these resources can approximate the replacement by natural or human-assisted systems.
- **Nonrenewable Resources** - naturally occurring raw materials which, because of their scarcity, the great length of time required for their formation, or their rapid depletion, are considered exhaustible. For example, petroleum.

4. Review how to identify packaging made from recycled materials *(Look for the recycling symbol.)*



Recyclable



Recycled

DOWN TO EARTH

99.5 percent of all the fresh water on Earth is in ice caps and glaciers.

Source: National Geographic

5. Distribute copies of Survey 1: *Product & Packaging*. Have students choose 10 products and complete the survey chart for each. Have students choose products that come in a choice of packaging and forms, such as cookies, rice, pasta or beverages.

Follow-up Questions for
Survey 1: *Products & Packaging*

Have students answer the following questions:

- Which products need special packaging to protect public health?
- Which packaging was made from recycled materials?
- Which products could be bought in bulk or large containers?
- Which products could be bought in a less processed or packaged form?
- Which packaging could be improved to save energy and resources and reduce waste?

6. Distribute copies of Survey 2: *A Potato By Any Other Name*. For homework, have students find a variety of potato products and complete the survey information. A guide is included with this lesson that shows some of the forms of potatoes students are likely to find.

Follow-up Questions for
Survey 2: *A Potato By Any Other Name*

- What effect do processing and packaging have on a product's cost?
- What effect does package size have on cost?
- What effect does package size have on the amount of waste?
- What else is added to food as it becomes more highly processed?
- List examples of recyclable packaging.
- List examples of products for which recyclable packaging is not available.
- List examples of packaging made from recycled materials.
- List ways people can reduce waste and increase recycling through careful buying.

Extension Activities

1. Have students create a guide to packaging that is recyclable in your area. Have them bring in samples of these recyclable packaging choices and packaging that is reusable. With these samples, have students create a display in the class or for the school. Be sure to include the specific types of plastic, by code number, that are accepted for recycling in your area. *(See the lesson entitled* Plastics By The Numbers.*)* For example, if milk jugs can be recycled in your area, then milk in plastic jugs is a better choice than milk sold in cardboard cartons that would end up in the trash and in the landfill. If a consumer has a choice between a product packaged in #7 Plastic or glass, recyclable and/or reusable glass is the better option.

2. Have students publish their packaging guide in the school newspaper. Have students illustrate packaging that can be recycled locally and where to take these items if curbside recycling is not available.

3. Two organizations, Green Cross and Green Seal, research and certify products based on different levels of environmental impact. Green Seal has a brochure on labeling. Send a self-addressed, stamped envelope for a class copy to Green Seal, 1875 Connecticut Ave., NW, Suite 300A, Washington, D.C. 20009. The Green Cross Certification Company, Consumer Affairs Department can be reached by writing 1611 Telegraph Ave., Suite 1111, Oakland, California 94612, or call
(800) 829-1416.

Just Do It

Make a list of items available in recyclable containers that your family buys often. Make sure everyone in the family understands these containers should be recycled when empty. Also review your buying habits and eliminate as many non-recyclable or non-reusable containers from your shopping list as possible.

Products & Packaging

Product	Renewable Organic (from living organisms)	Recyclable Recyclable Packaging	Nonrenewable Nonrenewable Recyclable Packaging	Resource Nonrenewable Nonrecyclable Packaging	Is this product necessary?	Is it available in more than one form of packaging?	Which is best in terms of recycling & waste reduction?	Is there an alternative to this product?	How could the packaging be improved to save resources & energy?	What happens to the packaging when the contents are used?	Will this product's packaging become part of SC's waste stream?
Variety-pack, snack-sized Potato Chips	Paper-board box	Paper-board box	Metallic	Metallic	Not critical	Yes	Large bags	Other snacks	Wax paper bags, larger bags, reusable tins	Landfilled or incinerated	Yes

BAKERS
CHIPS
FRIES
INSTANT
POTATO
BUDS

A Potato By Any Other Name

Product	Package Size	Price	Price Per Pound

BAKERS
CHIPS
FRIES
INSTANT
POTATO
BUDS

A Potato By Any Other Name

*(*Replace with local brands if necessary.)*

Product*	Package Size	Price	Price Per Pound	Recyclable Package?
Russet potatoes	bulk		$0.59	
White Potatoes	bulk		$0.49	
Red Potatoes	bulk		$0.69	
Fresh Potatoes	5 lb. (2.268 g)	$1.67	$0.338	
Fresh Potatoes	10 lb. (4.536 g)	$2.49	$0.249	
Bel-Air hash browns	2 lb. (907 g)	$1.29	$0.645	
Bel-Air french fries	2 lb. (907 g)	$1.59	$0.795	
Bel-Air shoe string potatoes	20 oz. (567 g)	$1.39	$1.12	
Ore-Ida potatoes O'Brien	24 oz. (680 g)	$1.49	$0.994	
Ore-Ida golden fries	32 oz. (907 g)	$1.69	$0.85	
Ore-Ida dinner fries	24 oz. (680 g)	$1.79	$1.20	
Betty Crocker potato buds (box)	28 oz. (794 g)	$2.99	$1.70	
Betty Crocker potato buds (box)	13.75 oz. (390 g)	$1.49	$1.73	
Town House mashed potatoes (box)	16 oz. (454 g)	$1.39	$1.39	
Town House white potatoes (canned)	15 oz. (425 g)	$0.57	$0.608	
S & W whole potatoes (canned)	16 oz. (454 g)	$0.75	$0.75	
O'Boises potato chips	6.5 oz. (184 g)	$1.15	$2.83	
Eagle potato chips	6.5 oz. (184 g)	$1.09	$2.68	
Pringles	7 oz. (198 g)	$1.50	$3.42	
Lays potato chips	10.5 oz. (298 g)	$2.28	$3.47	
Ruffles potato chips	15 oz. (425 g)	$2.75	$2.93	
McDonald's french fries	3.5 oz. (99 g)	$0.67	$3.06	

Action for a cleaner tomorrow.

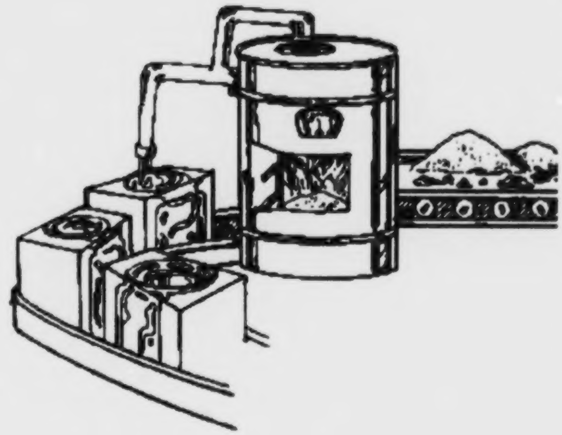
A South Carolina Environmental Curriculum

For more information about South Carolina and the environment, call the
South Carolina Department of Health and Environmental Control at
1-800-768-7348.

Glass Making

Preparation Time: Easy-To-Do Moderate **Extensive**

Grade: 6 – 8
Focus: Glass manufacturing and recycling
Subject: Science, Art, Social Studies
Materials: See list below
Teaching Time: Two 45-minute periods
Vocabulary: Heat, energy, natural resources, reuse, recycle, cullet, minerals



Learning Objective

Students will:

- recall some of the processes and resources in the manufacture of glass products
- describe how recycling glass is good for the environment
- make "glass" from spun sugar
- simulate glass blowing.

Background

Glass accounts for 6.6 percent of the solid waste stream generated in South Carolina. Glass is 100 percent recyclable, meaning that every pound of glass bottles and jars brought to a recycling center can be used to make new glass containers. (Mirrors and tempered or tinted glass for windows cannot be recycled.)

Glass is made by heating sand, lime, soda ash and **cullet** (crushed glass that has been collected for recycling) to a very high temperature until the mixture melts. As it cools, it is poured into molds and injected with air.

All bottles and jars were once made by glass blowers who blew bubbles with the molten glass mixture and formed them into shapes which hardened as they cooled. Today's manufactured bottles and jars are formed by injecting air into the molten glass mixture within molds.

The following activity simulates the making of glass, substituting sugar for sand, lime, and ash. This activity also simulates a common processes of plastics-making, called "blowmolding." Your students may also be interested to know that "sugar glass" is used in movie-making for "breakaway" windows and bottles. (For more information on glass, see the Resource section.)

Materials

- *Glass Manufacturing* illustration
- variety of glass objects (different shapes, colors and functions)
- for making glass (per group): 1 cup (50 g) sugar, hot plate, pan, 8" (20 cm) square sheet of glass (or substitute an 8" x 10" (20 cm x 25 cm) piece of glass from a picture frame), 1/4-cup (12 ml) water, newspaper, safety glasses, tongs or hot pad,

More than 95 percent of the United States residential curbside collection programs include glass.

Source: Glass Packaging Institute

balance, graduated cylinder, 250 ml beaker
- For molding glass (per group): 1 wide-mouth glass jar); per student: 1 stiff straw or glass tubing, balloon, rubber band

Learning Procedure

1. Hold up a glass object. **Ask:** Is this glass a solid or a liquid? Tell them glass is a liquid that has been cooled to form what appears to be a solid. Although it seems solid, glass remains a liquid. It's easy to see the effects of this in windows in old homes, for example. Glass, and the light coming through older windows, become distorted over time because the glass tends to "flow" toward the bottom.

Have the students touch the glass and describe the colors, shapes, and textures. Ask them what uses the many kinds of glass objects have. Hold the objects to the light and show how some reflect light, some are clear, and others are opaque.

2. Display the *Glass Manufacturing* illustration and explain to students how glass is made, emphasizing the **heat** and **energy** required during the process. Explain to students that the **minerals** are taken from the ground and heated to very high temperatures to make them melt. This process requires enormous amounts of energy. The supply of minerals and energy used to make glass is limited so we should not throw glass away.

3. Explain to students that glass jars can be re-melted to make new glass so these natural resources can be recycled. Ask students why recycling glass is good for the environment. *(Recycling glass **reuses** the **natural resources** which are in limited supply, saves energy.)*

4. Tell students that South Carolinians throw away most of the glass used in packaging. Ask students where the glass goes when it is thrown away. Explain that there is no such place as "away" and that all trash has to go someplace. Tell students that place is called a landfill. Explain that space in landfills is growing scarce because of how much we throw away and that we should try not to throw away so much trash. Ask if anyone knows how they can teach people not to throw away their glass. Write students' suggestions on the board.

5. ***Remind students to practice good safety habits during this step of the procedure.***
Start heating the water. Tell students you are going to make "pretend" glass using sugar in place of the real materials. Let students examine the sugar and describe it in terms of color, texture, shape and taste. Point out that the minerals used to make real glass are similar, but they come from the ground. Ask a student to describe sand. Have them describe the water and the changes in it as the heat begins to make it boil. Point out that heat energy is being used and show students the steam produced when water is boiled. Pour the sugar into the boiling water. Tell students to pretend the sugar is the minerals from the ground. Stir the mixture vigorously over the heat until the sugar is dissolved (about 5 minutes). Ask students to describe the changes in the sugar and water. Tell them this is how glass looks before it cools. Put several layers of newspaper under the sheet of glass. Carefully pour the mixture onto the sheet of glass and allow to cool (about 15 minutes). Proceed to the molding glass experiment.

6. Hold up the two sheets of "glass" so students can see through them. By allowing it to set overnight, the "glass" will become frosted. The next day, ask the students to describe the changes that occurred overnight.

7. (Optional) To illustrate the recycling of glass, scrape the dried "glass" back into the pan (call it "cullet," small pieces of crushed, recycled glass); add water and re-boil. More sugar will have to be added to repeat the procedure. Ask the students which resources were replaced when the cullet was used to make the new glass *(minerals, energy).*

Molding Glass

1. Divide the class into small groups of 4 - 6 students. Give each group a wide-mouth jar.

2. Give each student a straw or glass tubing, balloon and rubber band.

3. Attach the balloon to the straw with the rubber band.

4. Have students take turns putting the balloon into the jar and blowing it up until it takes the shape of the jar.

5. Explain that this process illustrates how glass is molded into a jar or other shape.

Extension Activities

1. Ask students to name some of the processes and natural resources used to manufacture glass. Students may illustrate the process, labeling the "natural resources" used to make glass and showing which ones are replaced when recycled glass (cullet) is used as a raw material.

2. Bring samples of handmade glass to class and show students the bubbles in the glass formed by a person blowing air into the hot glass mixture. Point out the irregularities that show the glass was handmade.

3. Have students research innovative uses for recycled glass such as "glasphalt" and insulation.

4. Have students write to the Carolinas Glass Recycling Program, 908 South Tryon Street, Suite 2200, Charlotte, North Carolina 28202, for information on glass recycling in the Carolinas.

5. Invite a glass blower to class to explain the techniques and demonstrate the art.

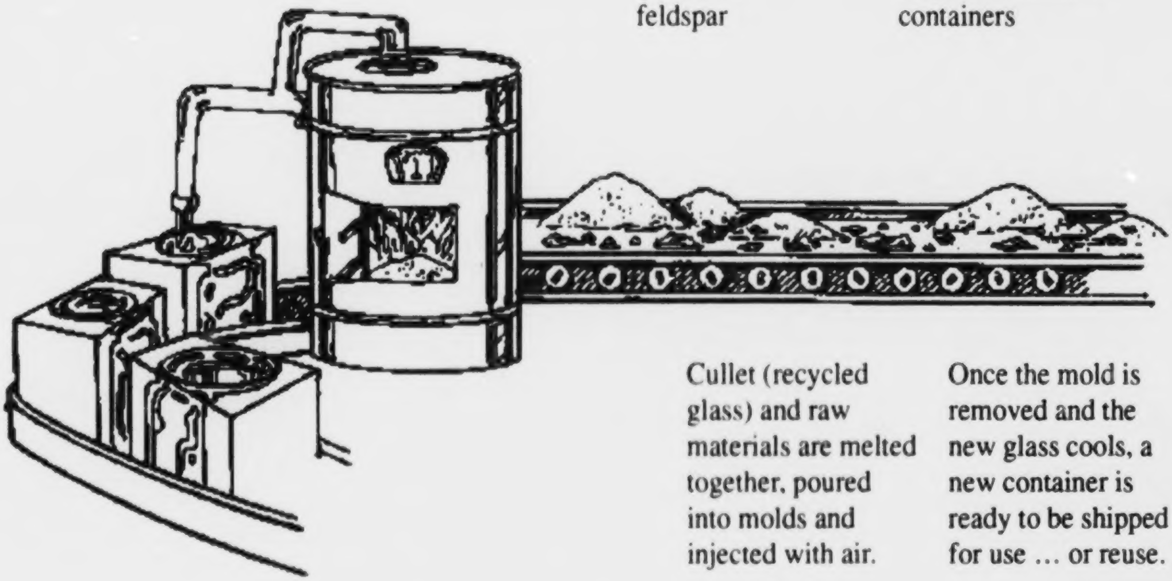
Just Do It

Find out if glass recycling is available in your area and, if so, what types of glass are accepted. Then ... recycle glass!

Glass Manufacturing

Raw Materials:
sand, soda ash,
limestone,
feldspar

Recycled Materials:
cullet or glass to be
recycled into new
containers



Cullet (recycled glass) and raw materials are melted together, poured into molds and injected with air.

Once the mold is removed and the new glass cools, a new container is ready to be shipped for use … or reuse.

1,330 pounds (603 kg) of sand, 433 pounds (196 kg) of soda ash, 433 pounds (196 kg) of limestone,
151 pounds (68 kg) of feldspar and 15.2 million Btus of energy are required to make just one ton of glass. Major deposits of white sand suitable for making glass are found in Illinois, New Jersey, the Alleghenies and the Mississippi Valley. Most soda ash comes from Wyoming and 65 percent of the feldspar in the United States comes from California and North Carolina.

Different colored glass is produced by adding small amounts of other substances such as iron, copper and cobalt. Green glass is made by adding iron.

Paper Recycling & By-Products

Preparation Time: Easy-To-Do Moderate **Extensive**

Grade: 6 – 8
Focus: How recycling conserves resources, saves money and reduces waste.
Subject: Science, Social Studies, Art
Materials: See list of materials itemized below
Teaching Time: Several class periods
Vocabulary: pH, contaminants, by-products, pollutants, heavy metals, distillates, wastewater treatment

Learning Objective

Students will:

- recycle paper to see the by-products of the process
- understand that by-products of all manufacturing processes pose potential environmental concerns.

Background

Paper cannot be recycled indefinitely because the fibers break down eventually. However, many grades of paper can be de-inked, cleaned and bleached; processes that allow paper to be reused as gameboards, tissue paper, ticket stubs, packaging, covers for hardcover books, insulation and animal bedding.

Although recycling paper saves natural resources and energy, pollution problems still exist in the production of recycled paper. To be recycled, waste paper must have **contaminants** removed.

Black printing inks used in newspapers are composed of about 30 percent pigment (usually carbon black) and about 70 percent petroleum-refined oil. Colored pigments in magazines – and increasingly in newspapers – contain **heavy metals**.

New low-rub inks and laser printing cause additional problems because they are difficult to remove from paper.

The paper-making process requires large amounts of water, all of which must be cleaned of contaminants. The remaining paper sludge also must be disposed of properly because petroleum **distillates** and heavy metals can remain present in this material. Both the contaminated water and sludge must be treated in a **wastewater treatment plant** before being released into the environment.

Materials

This lesson includes a papermaking exercise. The materials needed include:

- several sheets (at least 9" x 12" [23 cm x 30 cm]) of different types of used paper (newsprint, white office paper, construction paper, envelopes)
- nylon stocking, cheesecloth or millipore filter
- *Recycled Paper & Its By-Products* worksheet
- blender or egg beater & wide-mouthed container
- pans
- large mixing spoons
- cups to scoop with
- blotters
- dishwashing detergent
- sponges or towels to soak up water
- warm water
- a place to dry paper overnight
- iron (to help dry paper)
- litmus paper

DOWN TO EARTH

It takes up to 15 years for a tree to grow big enough to make into paper. Using recycled paper for one print run of the Sunday edition of the *New York Times* would save 75,000 trees.

Source: Going Green, Puffin Books

Questions for the Class

1. What natural resources are conserved when paper is recycled?

2. What kinds of paper can be recycled?

3. Does recycling solve all our paper solid waste problems?

Learning Procedure

1. Divide the class into small groups and have each group make recycled paper out of a different type of waste paper.

2. While making paper, students should collect the water that drains through the screen while the paper is being pressed to check it for **pollutants**. Have each group strain the collected water and sludge through a filter and examine what contaminants remain.

3. Have students use the collected water after straining and note its **pH**, color and sediment. Set samples aside (do not disturb) and repeat pH, color and sediment tests and observations after 24 hours. *(For another lesson on pH and water, see the lesson entitled, Death of a Lake.)*

4. Have each group complete the *Recycled Paper and Its By-Products* questions and discuss the results as a class.

Just Do It

Contact your local recycling center or DHEC's recycling information line
1-800-768-7248
to learn what types of paper are commercially recycled, the location of the collection centers and the proper way to bundle and separate different types of paper.

Questions on Recycled Paper and Its By-Products

1. What materials are in the sediment and sludge?

2. What is causing the discoloration of the water?

3. Is the strained water less polluted than the unstrained water? Why?

4. Should the remaining paper sludge be treated as solid waste or hazardous waste?

5. How can we reduce pollution problems?

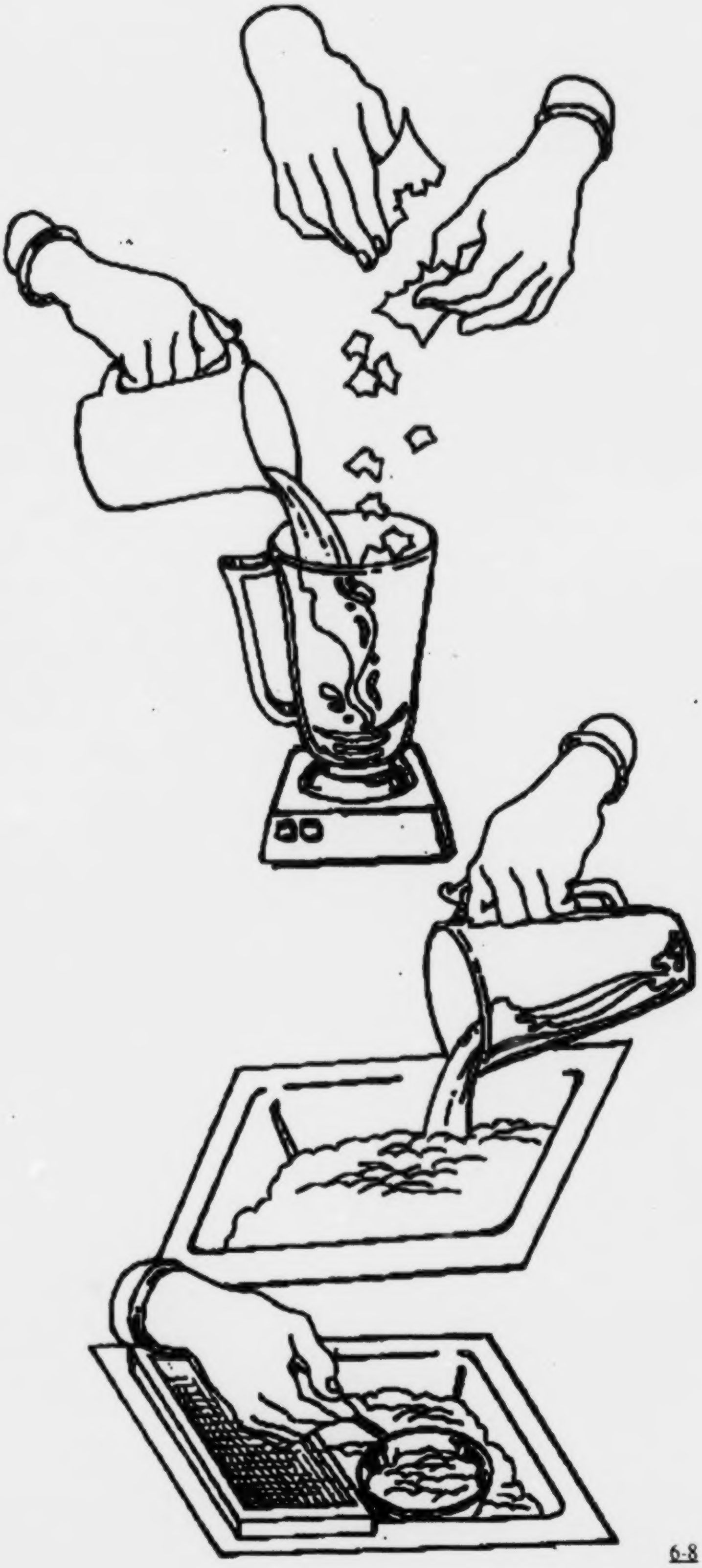
Extension Activities

1. Visit or write a South Carolina pulp mill. Find out if the mill uses only virgin timber, a mixture of virgin timber and recycled paper, or only recycled paper. Research the pollution control methods used in paper-making plants.

2. Research new soya-based inks and their effect on paper recycling.

3. As an art project, make recycled paper from various types of used paper, such as colored construction paper, white office paper, brown paper bags, etc. Students may also add bits of leaves, grass, flowers, pinestraw, and other natural elements.

Making Paper



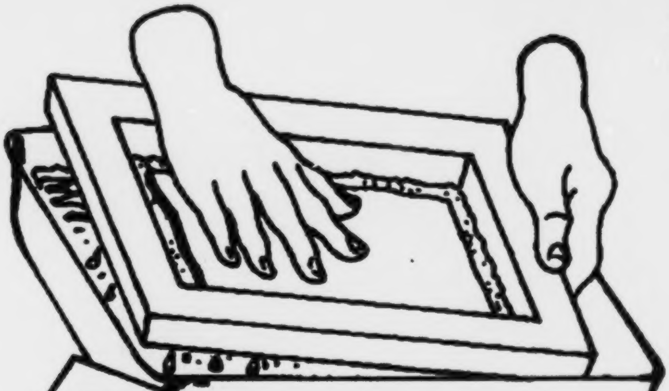
1. Tear sheets of used paper (one different type of paper for each group of students) into small strips about one-inch square. Loosely pack into blender until 1/3 to 1/2 full. Add warm water until blender is 2/3 full.

2. Blend, with lid on, until the paper looks like oatmeal (5 to 10 seconds).

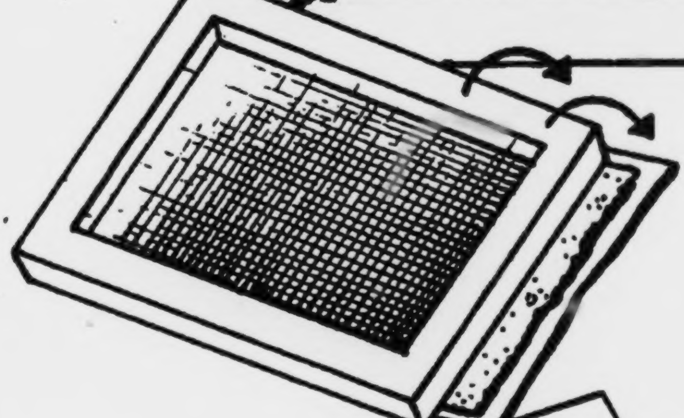
3. Empty the blender into a pan and add about 1/2 inch (1.3 cm) of water for every blender of pulp, adding more or less depending upon the thickness of paper desired.

4. Scoop the pulp mixture evenly onto the screen with a cup (hold the frame over half the pan). Let the pulp drain.

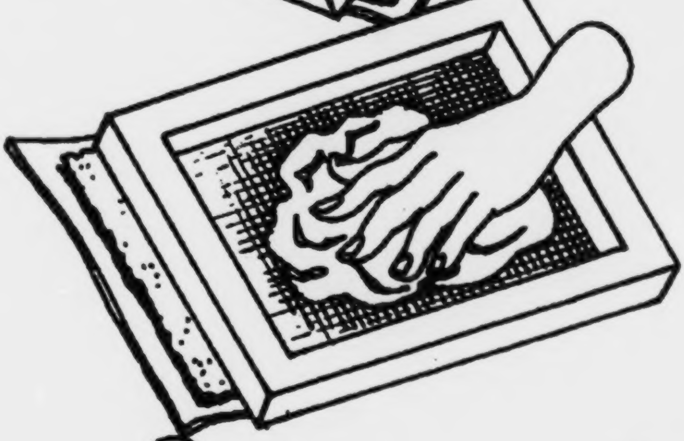
OPTION: you may dip the screen *under* the pulp and pull it up so that the pulp spreads out evenly on the screen. Don't forget to let the excess water drain into the pan.



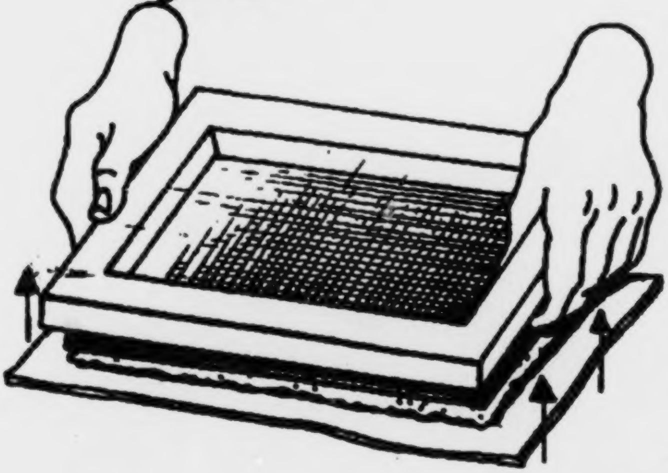
5. Place a piece of blotter paper over the wet pulp paper formed on the screen.



6. Flip the screen over so the pulp paper is between the blotter and the screen with the screen on top.



7. Soak up extra water with a sponge. This water can be squeezed out and collected along with the water in the pan.



8. Lift off the screen and place the new paper in a safe place to dry. Drying takes one or two days. Exchange blotter and dry paper towels every few hours if you want the paper to dry more quickly, or you may iron the paper to speed up the process. If you choose to iron your paper, place a sheet of paper between the new paper and the iron.

Life Cycles

Preparation Time: Easy-To-Do [✓ **Moderate**] Extensive

Grade: 6 - 8
Focus: Where do things we use come from and where do they go?
Subject: Language Arts, Social Studies, Science
Materials: Objects made of one material (each student brings an item to class), construction paper, markets, crayons, etc.
Teaching Time: One to two class periods
Vocabulary: Life cycle, natural resource, reuse, recycle, transportation, energy, recycle

Learning Objective

Students will:

- trace objects from their source, to the consumer, and back again to evaluate use and reuse of resources.

Background

Everything we make, use and throw away comes from and returns to the earth. Often, the level of waste associated with an item can be evaluated by examining the **life cycle** of the item: what **natural resource** it is made from; how it is made, used, and treated after use.

Learning Procedure

1. Ask each student to bring to class a common household object made from only one material, such as a rubber eraser, glass jar, piece of paper or plastic bag. Each student will identify the natural resources used and the steps taken to make the object and to deliver it to the consumer.

2. Have students trace all the steps needed to **recycle** the product into another object or to extend the item's life cycle. Illustrate the life cycle.

3. Discuss the steps required to produce the things we use each day. How many times is the object **transported** in its lifetime? By what? Using what **energy** source as fuel? Is the object easily **reusable**? Is it easily recyclable? What are the environmental effects of producing and transporting the object? See *From Where, To Where* (included with this lesson).

Extension Activities

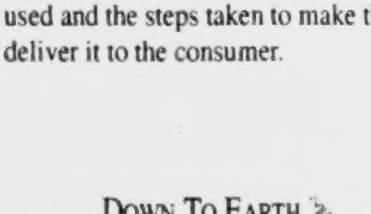
1. Trace the life cycle of a pencil or other commonly used, inexpensive object made from several different resources. Is a pencil easily recyclable?

2. Trace the life cycle of a newspaper. Then trace the life cycle of newspaper that is recycled and/or reused a few times. What is saved by the recycling?

3. Compare the life cycles of two items you could use for the same purpose. (Paper towel vs. washable dish cloth.) Determine the one with the least wasteful life cycle.

Just Do It

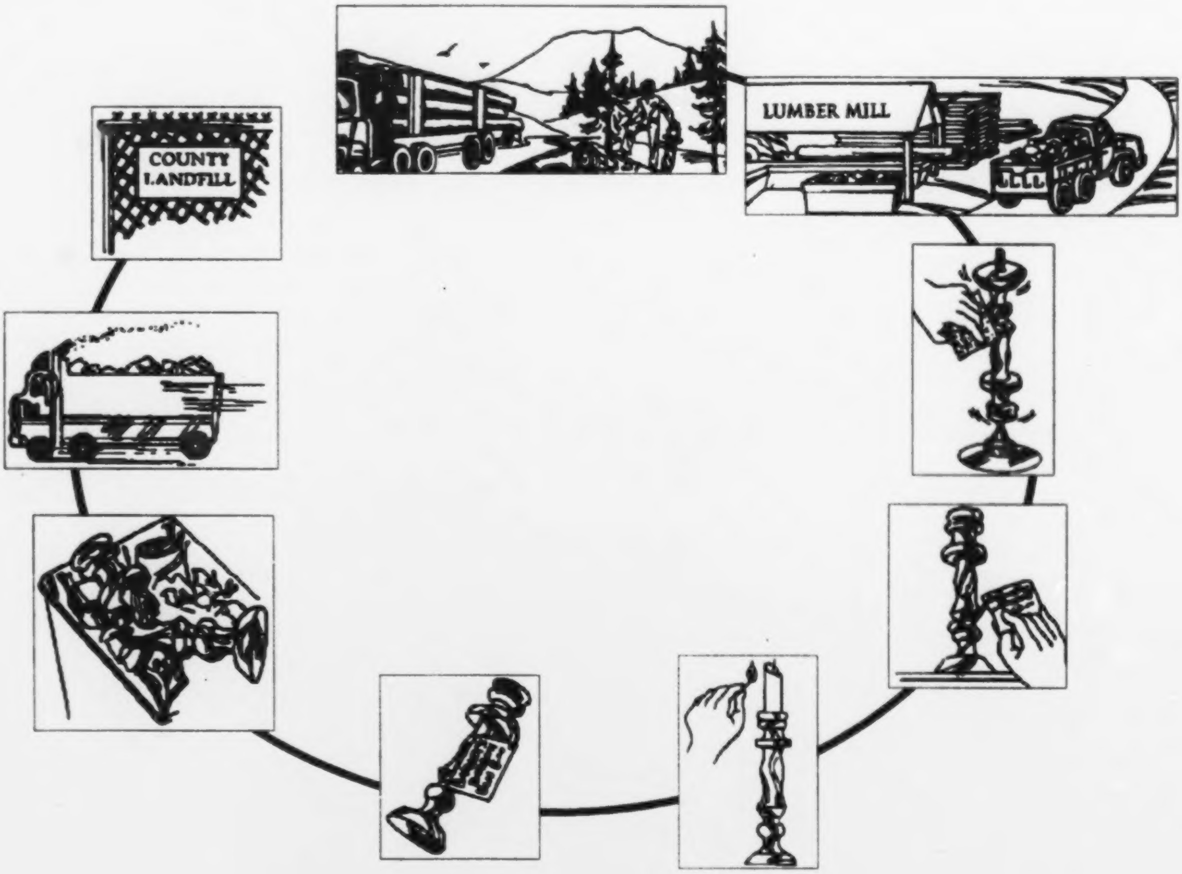
Don't cut an item's useful life cycle short!
Always look for one more way to use an item.
For example, donate old clothes
and toys to thrift stores or
cut up old t-shirts to use as polishing cloths.



Mt. Everest is the world's tallest mountain, but it is also the world's most elevated trash dump. Up to 50 tons of garbage has been tossed along the sides of the mountain since 1953. In 1993, $740,000 was spent on an expedition to attempt to clean up the mess.

Source: *1994 Information Please Environmental Almanac*

From Where, To Where?



A tree is cut down by a logger.
A truck hauls the log to the mill.
The mill processes the log into furniture-grade wood.
The furniture factory buys the wood.
A truck hauls the wood to the factory.
The furniture factory makes the wood into candlesticks.
A truck hauls the candlesticks to a distributor's showroom.
The distributor sells the candlesticks to a retail store.
A truck hauls the candlesticks to the retail store.
A consumer buys the candlesticks from the store.
The consumer transports the candlesticks home and uses them.
The consumer tires of the candlestick design and transports them to a thrift store.
A consumer purchases the candlesticks from the thrift store.
The consumer transports the candlesticks home and uses them.
The consumer breaks one of the candlesticks and tosses it into the trash.
The trash is picked up and hauled to a transfer station where it is compacted with other wastes.
The wastes are hauled to a landfill.
The wastes remain in the landfill.

Recycling: It's An Energy Issue

Preparation Time: Easy-To-Do · **Moderate** Extensive

Grade: 6 – 8
Focus: Energy awareness, economics of recycling
Subject: Science, Math
Materials: See list below
Teaching Time: One class period
Vocabulary: Btu, energy, direct energy, indirect energy, embedded energy, recycling, cullet, virgin materials, HDPE, PET

Learning Objective

Students will:

- understand embedded energy
- identify how energy becomes embedded in a product
- calculate the percent of energy saved when comparing the energy consumed by processing virgin materials versus recycling various materials
- conclude that recycling saves both direct and embedded energy.

Background

According to the Environmental Protection Agency, in the year 2000 the U.S. will bury or burn:

- 11.4 million tons of newsprint
- 16.2 million tons of corrugated cardboard
- 10.8 million tons of glass packaging
- 8.2 million tons of plastic packaging
- 1. 5 million tons of aluminum packaging.

This totals 48.1 million tons of buried or burned solid waste, a fraction of the total 280 million tons of commercial, residential and institutional waste generated in the U.S. each year. (See the Resource section for South Carolina's waste stream components.)

United States' energy consumption has increased an average of 1.1 percent every year since 1970.

If this 48.1 million tons of material were recycled instead of being buried or burned, the United States would save the equivalent of 10.1 billion gallons of gasoline. That is enough gasoline to power 15.4 million cars for one year *(assuming 18.3 miles per gallon and 12,000 miles per year).*

In addition, the use of recycled materials results in the reduction of water use, water pollution, air pollution and energy consumption. Yet, the U.S. currently only recycles about 14 percent of the 280 million tons of garbage it generates each year. *(Source: 1993 Environmental Almanac)*

The energy used to manufacture a product is a **direct energy** cost. But there are indirect energy costs, too. The energy used to obtain raw materials, for transportation, distribution and even the disposal of an item contributes to **indirect energy** costs. Direct energy costs plus indirect energy costs are referred to as **embedded energy**. *(The total amount of energy a product uses in its "life.")* Both direct and indirect energy costs can be reduced through recycling. The *Energy in Waste* scenarios (included with this lesson) provide estimates of how much embedded energy can be saved by recycling certain products.

DOWN TO EARTH

Although only 5 percent of the world's people live in the United States, the nation accounts for 25 percent of the world's energy consumption.

Source: 1993 Environmental Almanac

Materials

Overhead transparency of *The Environmental Effects of Resource Use* or copies for a group of students, copies of the worksheet *Energy in Waste Analysis*, one copy of the *Energy in Waste* scenarios for each group.

Learning Procedure

1. Write "energy" on the board. Ask students for examples of different kinds of energy *(light, heat, mechanical, chemical, nuclear, and electrical, etc.)*. Write "direct energy" and define it as the energy it takes to manufacture a product or provide a service.

2. Write "indirect energy" on the board and help students define it as the energy used to make and move products that is not directly involved in the production process.

3. Write "embedded energy" on the board. Ask students to develop a definition of the term. Remind students that all matter contains energy. Once something is moved or manufactured, it also has embedded energy. The amount of embedded energy depends on the amount of processing involved. Point out that embedded energy costs are very useful when scientists are evaluating different processing or manufacturing options.

4. Project the overhead, *The Environmental Effects of Resource Use*. Discuss each of the three steps involved in resource use. Have students identify how direct and indirect energy is used during each step. Point out the environmental effects of each step. Leave the overhead projector on so students can use the overhead to fill out the worksheet.

5. Divide the class into groups of four students. Give each group a set of the *Energy in Waste* scenarios. Give each student a copy of the worksheet *Energy in Waste Analysis*.

6. Instruct students to read each scenario and fill out the chart for each category of waste. Each student should calculate the percentage of energy savings and identify sources of embedded energy *(direct and indirect)* in both new materials and recycled stock. *(An alterative is to have one student in each group act as the reader while the other students record the information.)*

7. Review the procedure for calculating percentage.

STEP 1:

(Energy costs for new materials) — (Energy costs for recycled materials) = (Energy Saved)

STEP 2:

{(Energy saved) ÷ (Energy cost for new materials)} x 100 = (% of Energy Saved)

(For example: To make copper from ore requires 280 million Btus per ton; to make copper from scrap requires just 10 million Btus per ton. This is a savings of 270 million Btus per ton (280-10 = 270) and 270 ÷ 280 x 100 = 96% savings. A British thermal unit [Btu] is the amount of heat energy required to raise the temperature of one pound of water by one degree Fahrenheit.)

8. After students have completed their worksheets, have them write a conclusion by comparing new materials versus recycled stock. Their conclusions must be based on their analysis of the embedded energy used or saved.

Evaluation

1. The students will have correctly calculated the percentage of energy saved for five materials: *(paper = 67%; glass = 6%; PET plastic = 88%; HDPE plastic = 78%; aluminum = 95%)*
2. Based on the data from the worksheet, students will conclude that recycling saves large amounts of embedded energy.

Questions for the Class

1. How much embedded energy is there in a car? Have students discuss the raw materials typically contained in a new car. Have students make a mural showing the embedded energy in each of the materials as they flow together to form a car.
2. Convert the energy savings from Btus to other forms of energy by using the following factors:
   - one gallon of gas has 124,000 Btus
   - one kwh of electricity has 3,400 Btus
   - one ton of coal has 25,400,000 Btus

Extension Activities

1. Energy use and global environmental issues such as the "greenhouse effect" are closely linked. Have students work together to develop a chart that shows how energy use, recycling, energy and global warming and the greenhouse effect are linked. For more information, see the chapter, "All This, and CO_2," from the book, *50 More Things You Can Do To Save The Earth*. Make arrangements for the chart to be displayed in the cafeteria.

World Primary Energy Consumption

(in quadrillion Btus, 1991)

North America	863.1
USA	780.8
Canada	82.3
Latin America	161.3
Western Europe	553.8
Former Soviet Union & Central Europe	642.8
Middle East	94.6
Africa	87.1
Asia & Oceania	720.2
World	**3,123.0**

Source: BP Statistical Review of World Energy (British Petroleum, London, June 1992.) pg. 34.

The Environmental Affects of Resource Use

Steps	**Energy Costs**	**Environmental Effects**
Mining exploration extraction	?	disturbed land, mining accidents & health hazards, mine waste
Processing transportation, purification, manufacturing	?	solid wastes; radioactive material; air, water & soil pollution; noise; safety & health hazards
Use transportation, transmission to the individual users, eventual use, and discarding	?	noise; thermal, air, water & soil pollution, solid & radioactive wastes, safety & health hazards

Energy In Waste Analysis

(Energy Costs in Millions of Btus per Ton)

							Sources of Embedded Energy	
Materials	Energy Costs (New Materials) —	Energy Costs (Recycled) =	Energy Saved ÷	Costs (New)	x 100 =	% Energy Saved	New Materials	Recycled Materials
Paper					100			
Glass					100			
PET Plastic					100			
HDPE Plastic					100			
Aluminum					100			

Conclusions:

Energy In Waste

• **Paper** makes up 37.6 percent of South Carolina's solid waste stream.* Depending on the kind of paper being made and mill efficiency, using recycled stock reduces energy use by 25 to 75 percent when compared to using virgin pulp stock. To make a ton of newsprint from virgin pulp requires 30 million Btus; using pulp from used newsprint requires only 10 million Btus per ton.

• **Plastics** make up 9.3 percent of South Carolina's solid waste stream.* These are ideal candidates for recycling because they are literally made of fossil energy — about 30 percent oil and 70 percent natural gas. Soft drink bottles (made of polyethylene terephthalate or **PET**) cost about 98 million Btus per ton to make. Bottles made of recycled PET needs only about 12 million Btus per ton. Another high-use plastic that has great potential for recycling is high density polyethylene (**HDPE**) used to make such items as milk jugs and detergent bottles. The United States produces about three times more HDPE than PET. Recycling one ton of HDPE saves about 76 million Btus. A ton of virgin HDPE "costs" about the same as a ton of PET.

• **Glass** makes up 6.6 percent of South Carolina's solid waste stream.* Recycling glass usually begins with color separation followed by grinding the glass into small pieces called **cullet**. Energy is saved because the cullet melts at lower temperatures than new materials. To make a ton of glass from new materials requires 16 million Btus per ton; less than 15 million Btus are needed to make a ton of glass from cullet. The energy needed for throwaways is 58,000 Btus per gallon.

• **Aluminum** and other metals make up 8.3 percent of South Carolina's solid waste stream.* About 95 percent of the energy needed to produce aluminum from bauxite ore is saved by substituting aluminum scrap. Estimates on the energy costs for extracting a ton of aluminum from bauxite average 250 million Btus per ton; only 12.5 million Btus are needed to produce a ton from scrap. Recycling other metals produces similar energy savings.

---

* Percentages calculated by weight. Source: *South Carolina Solid Waste Management Plan, 1995*

The Bottom Line of Recycling

Preparation Time: **Easy-To-Do** Moderate Extensive

Grade: 6 – 8
Focus: Recycling makes good economic sense.
Subject: Social Studies, Economics
Materials: Chart included with lesson
Teaching Time: 30-minute discussion
Vocabulary: Recycling, market, demand, profit

Learning Objective

Students will:

- see that financial reward – the profit motive – plays an important role in making recycling happen
- determine that, for recycling to be effective, there must be a market for recyclable materials and for recycled goods.

Background

Education and a sense of responsibility for the environment increase participation in **recycling**, but financial reward is also a catalyst to action. Saving recyclables is useless though if there is no place nearby to recycle the materials. For recycling centers to exist, there must be a market, in other words there must be: 1) a **demand** for the recycled materials the center collects (consumers purchasing more recycled materials creates this demand), and 2) a chance to make a **profit** running the recycling center (or in the case of municipal recycling programs, a chance to break even to pay for the program).

In many areas of the state, recycling is available. For example, areas of downtown Columbia offer curbside recycling along with regular trash pickup. In other areas of our state, recycling centers accept drop-offs of recyclable materials.

In some states recycling is mandatory. For example in Oregon, by law, all communities with a population of 4,000 people or more must have some form of curbside recycling.

What Would You Do

	A - If I Asked You	B - If I Paid You
1. Wear white gloves to school all day		
2. Eat a raw onion		
3. Stop drinking soda for one month		
4. Help an injured person and miss a concert		
5. Pick up litter on weekends		
6. Recycle everyday		

DOWN TO EARTH

Would you pay more for an electric car with an emission level of zero? In the very near future battery-powered cars will be available in the United States. Call Ford at 1 800-ALT-FUEL, or GM at 1 800-25ELECTRIC for more information.

Source: *GreenWatch*, Good Housekeeping, Dec. 92

Questions for the Class

1. Do you know what is recyclable in your area?

2. What is the best way to motivate people to recycle and to operate recycling centers?

Learning Procedure

1. Make the *What Would You Do* chart on the board or overhead similar to the one included with this lesson. For discussion purposes, you may set a limit for the column, If I Paid You, such as $20.

2. Record student responses to column A, then column B. For example:

a. Would you wear white gloves to school all day if I *asked* you?
b. Would you wear white gloves to school all day if I *paid* you?

a. Would you eat a raw onion if I *asked* you?
b. Would you eat a raw onion if I *paid* you?

a. Would you stop drinking soft drinks for a month if I *asked* you?
b. Would you stop drinking soft drinks for a month if I *paid* you?

a. Would you help someone who was hurt and miss a concert if I *asked* you?
b. Would you help someone who was hurt and miss a concert if I *paid* you?

a. Would you pick up litter on weekends if I *asked* you?
b. Would you pick up litter on weekends if I *paid* you?

a. Would you recycle everyday if I *asked* you?
b. Would you recycle everyday if I *paid* you?

You may want to create your own set of questions concerning local issues.

3. **Ask:** What differences do you see between column A & B? Why? **Ask:** If we want people to recycle, what is a good way to get them to do it? Is it enough for people to be educated about the benefits of recycling? Or do we need to provide an economic incentive?

What about the people who run the recycling centers: Why do they do it? What do these people need to be able to keep running their businesses? What would happen if they had no one to sell their recyclables to?

What has to exist in order for a recycler to sell recyclables? *(There has to be a market demand.)*

If sufficient markets for recyclables do not now exist but the public demands that more waste be recycled rather than dumped in the landfill or incinerated, should the government help create markets for recyclables? How?

What are some things government can do to stimulate recycling? Are there problems if the government gets involved? What do you think the government should do?

Extension Activity

Invite a representative from the recycling industry to visit your class and explain the business. For a current copy of *South Carolina Recycles*, a directory of recycling programs and markets in the state, contact S.C. DHEC at 1-800-76-USE-IT. Plan a series of interview questions for your guest.

- What recyclables does the business handle?
- Does the business pay for these materials? If so, how much?
- How does the business make money?
- Where do the materials end up? What do they become?

Making a Compost Pile (or) Lawn Lasagna

Preparation Time: Easy-To-Do [✓ Moderate] Extensive

Grade: 6 - 8

Focus: Composting, organic gardening

Subject: Science, Biology, Horticulture, Vocational Agriculture, and Home Economics

Materials: Organic materials containing carbon such as dead leaves, tea leaves, and coffee grounds; materials containing nitrogen such as green grass clippings, green leaves; soil

Teaching Time: Several class periods over a couple of weeks

Vocabulary: Compost, biodegrade, carbon, humus, decomposition, nitrogen

Learning Objective

Students will:

- learn the basics of composting
- understand how composting reduces yard and garden waste
- learn the basics of soil construction.

Background

Composting can significantly reduce the volume of residential solid waste.

Composting is the natural decomposition of organic materials through biological activity. Naturally occurring bacteria break down leaves, grass clippings, kitchen scraps and other organic wastes into a material called **humus** or compost that looks, feels and smells like soil. A traditional means of reducing and recycling organic wastes, composting is receiving renewed attention.

There are three main types of composting.

- Nature's recycling – This occurs naturally on forest floors as fallen leaves and tree limbs **biodegrade** into rich humus. Nature replenishes itself this way without human intervention and returns nutrients to plants and trees.
- Backyard composting - This has been practiced by gardeners for years, turning garden and yard clippings into a nutrient rich soil enhancer. Organic materials are usually collected in a pile or bin in the backyard. Air, water and heat help break down materials into humus for future planting.
- Municipal composting - This is a new and exciting application of traditional composting. Thousands of communities already compost their leaves, grass and yard trimmings. These communities have special trucks pick up the yard wastes and take it to a central composting site where it is turned into humus that can be sold or given away to gardeners in the community. Unlike landfills, a composting site can be continually reused without ever reaching capacity. If properly constructed and managed, municipal composting is sanitary and produces no offensive odors.

South Carolina has 63 composting and wood chipping/shredding facilities.

DOWN TO EARTH

One of the world's largest composting piles, the Netherland's Waste Treatment Company produces about 125,000 tons of compost a year. This is sold for farm and garden uses.

According to figures from the 1995 South Carolina Solid Waste Management Plan, 15.9 percent of our solid waste is lawn and garden waste. In many South Carolina communities, yard wastes are collected and taken to local composting facilities. In most areas, the demand for the rich compost material is greater than the amount of compost available.

Yard wastes do not belong in our landfills. Because of the construction of today's modern, sanitary landfills, waste – even yard clippings – do not biodegrade in the landfill. The South Carolina Solid Waste Policy and Management Act forbids the disposal of yard waste and land-clearing debris in municipal landfills after May 27, 1993. (For more information on composting, see the Resource section.)

Learning Procedure

Version One: Building a Hot Compost Pile

Hot piles are useful for composting food and yard wastes together. The advantages of hot compost piles are: they are free of pests, kill soil diseases and weed seeds, and produce compost quickly.

1. Using the following instructions, build a hot compost pile. Gather all the materials needed to make a pile at least three feet cubed. Use both green and brown materials. Green materials provide **nitrogen** needed for **decomposition** and include fresh grass clippings and yard trimmings. Cottonseed meal, blood meal and manure are also high in nitrogen. Brown materials provide **carbon** and include dead leaves, straw and sawdust. Strive for a 30 to 1 carbon to nitrogen ratio. *(Alternating layers of brown and green materials of the same thickness produces this ratio.)*

2. If possible, shred or chop materials.

3. Start building the pile with a 4 – 6 inch (10 – 15 cm) base of (brown) carbonaceous material. If no food wastes are included and the pile is going to sit for more than a few weeks, use coarse material such as corn stalks for this base layer to let air into the pile. Moisten materials.

4. Next add a 4 – 6 inch (10 – 15 cm) layer of high nitrogen materials. If the greens are not fresh, sprinkle on a small amount of cottonseed or blood meal, poultry manure, or other high nitrogen source. High nitrogen wastes such as fresh grass clippings or food should be used in 4 – 6 inch (10 – 15 cm) layers. Food waste should not include meat, fats, or oils because they attract scavenging animals. Mix green and high nitrogen materials.

5. If you choose to build a bin to hold the compost, fill the bin. Alternate layers of green and brown materials, adding water and extra nitrogen as needed until the pile is three to four feet high.

6. Cover the pile or close the bin, if extreme wet or dry climatic conditions require it. Regularly monitor the temperature in the pile's interior. It should peak between 120 to 160 degrees Fahrenheit (49 to 71 degrees Celsius). (In winter, it will steam.)

7. When the temperature increases to between 120 and 160 degrees Fahrenheit (49 and 71 degrees Celsius), turn the pile. Take materials from the outer edges and top of the pile and put them at the base and in the middle of the new pile. Materials from the center should be on the outer edges and on top of the new pile.

8. Monitor the temperature in the new pile.

9. In about a week, the temperature should peak. Turn the pile again. After another week, the compost should be finished.

Version Two: Changing the Conditions

1. Using the layering and turning method described in Version One, start five experimental compost piles in bins or five-gallon buckets, four of which have holes drilled in the sides.

The five experimental conditions:

a) Low in nitrogen
  - No high nitrogen materials

b) Not enough moisture
  - Don't water and exclude wet components

c) No air (anaerobic)
  - Use bucket without holes
  - Do not turn

d) No carbonaceous material

e) Good compost pile

- Proper 30-to-1 ratio of brown (carbonaceous) to green (nitrogenous) materials
- Layer materials
- Keep moist
- Turn regularly

2. Keep a daily record of the temperature of each pile.

3. After three or four weeks, discuss the results. **Ask:** What are the necessary components of a good compost pile? Why does the good compost pile break down wastes faster than the others? How do the components of a compost pile work together to decompose materials? How is recycling within the compost pile like the nitrogen cycle and other natural cycles in our biosphere? *(The nitrogen cycle is the continuous, cyclic progression of chemical reactions in which atmospheric nitrogen is compounded, dissolved in rain, deposited in the soil, assimilated and metabolized by bacteria and plants, and returned to the atmosphere by organic decomposition.)*

- Where is composting occurring naturally?
- What are the environmental impacts of dumping compostable, organic wastes in landfills? *(Decomposing organic material produces methane gas, which can be explosive.)*
- Why does composting make sense? *(Composting can significantly reduce waste volumes, reduce the production of methane gas, provide a beneficial soil conditioner by recycling natural elements and nutrients.)*

Questions for the Class

1. What is composting?
2. What are the necessary ingredients for a good compost pile?
3. How does composting promote recycling?
4. How can composting reduce waste?
5. What is the proper compost mix of brown (carbonaceous) materials and green (nitrogenous) materials?

How the Compost Pile Grows

Soil: contains microorganisms that help decomposition.

Organic Wastes: leaves, food scraps and grass clippings. Wastes should be varied including materials with high carbon and high nitrogen content. By alternating these materials you create good environmental conditions for decomposition.

Nitrogen: many of the organisms responsible for decomposition need nitrogen. Nitrogen is found naturally in many organic wastes, such as manure and green grass clippings.

Carbon: brown materials such as dead leaves, straw and saw dust.

Worms: they eat waste, helping to break it down. Worms make droppings that enrich the soil and tunnel through and aerate the waste. As the worms eventually die, they become part of the compost.

Water: necessary for normal functioning of life. Too much water in a compost pile may make it soggy and slow to decompose.

Air: the biological activity of fungi, bacteria, small insects and organisms results in decomposition. Most biological processes require oxygen.

Time: decomposition takes time. To speed it, aerate your compost pile every few days.

Heat: heat is produced by chemical reactions resulting from increased biological activity that occurs during decomposition. Heat helps sanitize compost by killing certain organisms such as weed seeds and harmful insect larvae.

Mass: to generate enough heat for optimal decomposition, the pile must contain at least one cubic meter of organic material. The temperatures generated in a small pile are different than those generated in one that is larger.

Action for a cleaner tomorrow.

A South Carolina Environmental Curriculum

For more information about South Carolina and the environment, call the
South Carolina Department of Health and Environmental Control at
1-800-768-7348.

Help Wanted

Preparation Time: **Easy-To-Do** Moderate Extensive

Grade: 6 – 8

Focus: Environmental occupations, advertising

Subject: Social Studies, Language Arts

Materials: Copies of help wanted display ads from waste management or environmental trade journals (these can be found in most county libraries or you may take students to the library to do their own research), colored markers and paper

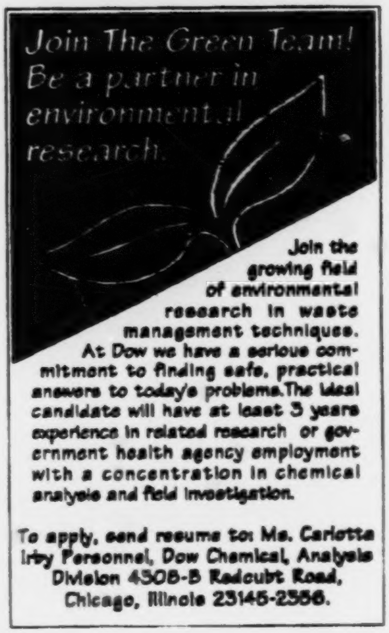
Teaching Time: One or two class periods

Vocabulary: Advertisement, logo, headline, body copy, trade publications

Learning Objectives

Students will:

- identify potential occupations and educational requirements for careers in environmental fields
- identify the major parts of a display advertisement
- prepare an advertisement for a waste management publication.



Join The Green Team! Be a partner in environmental research.

Join the growing field of environmental research in waste management techniques. At Dow we have a serious commitment to finding safe, practical answers to today's problems. The ideal candidate will have at least 3 years experience in related research or government health agency employment with a concentration in chemical analysis and field investigation.

To apply, send resume to: Ms. Carlotta Irby Personnel, Dow Chemical, Analysis Division 4308-B Redcubt Road, Chicago, Illinois 23145-2356.

Background

As the number of people living in South Carolina grows and the amount of waste each person produces grows, there will be a corresponding need to employ people in the waste management industry and in environmental positions in a host of industries.

The competition in the waste management industry is growing. Many of the small "mom and pop" recycling shops are going out of business and large corporations are becoming more involved in comprehensive waste management programs. South Carolina cities and counties are literally spending millions of dollars on waste and protecting the environment.

Green professions are in demand. Manufacturing, production and management strategies are being revamped. Companies are examining every aspect of business from the extraction of raw materials to the disposal of the final product. This includes purchasing, public relations, marketing, financial management, research and development, accounting, sales, personnel, training and strategic management.

- Environmental consultants are regularly called in when companies are making transitions.
- Banks need environmental investors and researchers.

DOWN TO EARTH

Canada's Green Plan commits the nation to protecting a full 12 percent of its land and water by the year 2000.

- Businesses are needed to create new technology for clean-ups.
- The petroleum industry needs environmental engineers, biologists and consultants to perform studies on the environment.
- Chemical firms also need environmental engineers as well as compliance administrators and product and marketing managers.
- Organic foods have created a niche in industry. Experts are needed for pest management, organic gardening, retailing of organic food and mail order sales.
- Environmental lawyers are needed.
- Insurance companies have had to acquire the cost of cleaning up wastes left by firms carrying their policies.
- Environmental regulators, such as those at S.C. DHEC and the U.S. EPA, enforce laws.

These are just a few examples of the edge given to those in the job market that are environmentally educated. There are many more.

As employment opportunities grow, the need for people with special skills also grows. These specialists often advertise their services and expertise in national business newspapers and trade publications that are targeted to specific audiences.

Learning Procedure

1. **Ask:** Do you know someone who works in an environmental profession? (Have them explain what the person does.) **Ask:** Have you ever considered an environmental career for yourself? How would you research what kind of jobs are available in environmental professions?

2. Explain to the class that one way to find out is to review trade publications. **Trade publications** are magazines and newspapers written specifically to professionals working in a single industry.

Give students copies of the Help Wanted ads you have obtained form these publications or plan a trip to the local library. (You'll need to call the librarian in advance to ensure that they have copies of several environmental trade journals such as *Waste Age*, *Recycle*, *Garbage*, and *Chemical Week*)

3. Have students identify 10 different environmental jobs by reviewing the advertisements in these publications. Have them note the name of the company, the type of business, the type of job, and the location of the company.

4. Discuss the format of the display **advertisements** *(display ads are the large boxed ads with art, not the line-by-line ads).* What things do the advertisements have in common? *(**logo**, **headline** or large type, **body copy**, art, borders, company name, address and phone)* What makes one advertisement more appealing than another? Develop a class checklist of items that should be included in successful help wanted advertisements.

5. Tell the students they will be creating display advertisements for a national circulation waste management magazine. Each advertisement should have a logo, a description of the services their company offers and the kinds of positions that are available. Students should use different colors in their advertisements.

6. Distribute the paper and colored markers. Have students decide create an advertisement .When the students have completed their advertisements, tape them to the wall or board and have students critique each others' work. They should use the checklist to be sure each advertisement contains all the essential information.

Extension Activity

Arrange for a guest speaker from a local waste management firm or government agency to visit your class to discuss employment opportunities, educational requirements and job qualifications.

Just Do It

Find out if there any environmental businesses or companies in your community.

PROFESSIONAL SERVICES

Killam
Full Recycling Consulting Services
Headquarters:
27 Bleaker Street
Millburn, NJ
201-379-3400

5085 Reed Road
Columbus, OH 43220
614 459-2050 ■ Fax 614 451-1385
Akron, OH ■ Cincinnati, OH ■ Columbus, OH ■ Crestview Hills, KY
Painesville, OH ■ Parkersburg, WV ■ Payson, AZ ■ Phoenix, AZ
ENGINEERS
ARCHITECTS

CDM
environmental engineers, scientists, planners, & management consultants
CAMP DRESSER & McKEE INC.
One Cambridge Center
Cambridge, Massachusetts 02142
617 621-8181
offices nationwide

COMPOST STABILITY AND QUALITY ANALYSIS
SKILLED TESTING AND CONSULTING SINCE 1974
--PROCESS EVALUATION
--QUALITY CONTROL
--FIELD TESTING
--CLASSIFICATION
--FEASIBILITY STUDIES
For free literature and more information, contact:
• BOX 1850, OLD ROME AVENUE, MT. VERNON, MAINE
USA: 04352 -tele: 207-293-2457 FAX 207-293-2488
• BOX 79, KINGS COURT, STROUD, GLOUCESTERSHIRE
United Kingdom (UK) GL5 3PU -tele: (0453) 763290
WOODS END RESEARCH LABORATORY, INC.

Gannett Fleming
76th Year
COMPLETE ENVIRONMENTAL SERVICES
Solid Waste and Sludge Management
• Composting • Landfills
• Transfer Stations • Intensive Recycling
P.O. Box 1963, Harrisburg, Pennsylvania 17105
(717) 763-7211
OFFICES NATIONWIDE

BIO-REMEDIATION • MSW • URBAN FOREST
COMPOSTING [illegible] WASTE
BIO-THERMIC RESOURCE RECOVERY
EQUIPMENT
BILL NEWLAND
(408) 674-0530
CONSULTING
DAN HATHAWAY
(808) 329-8043
P.O. Box 1086 • Salinas, CA • 93902-1086

INTERSCAPE BROKERS CORP.
DISTRIBUTORS OF
ENVIRONMENTALLY FRIENDLY
HUMA GRO PRODUCTS
Environmental
Horticultural
Services and
Consulting
JEFF FRANK
P.O. BOX 254
WESTHAMPTON, N.Y. 11977
(516) 325 2076 (516) 288 1598

George B. Willson Associates
Consultant on
Composting/Organic Waste Recycling
608 Washington Blvd.
Suite 303A
Laurel, Md. 20707 301-490-1064

RMI RESOURCE MANAGEMENT INTERNATIONAL, INC.
■ WASTE REDUCTION/RECYCLING ■ SITING
■ SOLID WASTE PLANS & PERMITS ■ DISPOSAL ALTERNATIVES
■ TECHNICAL REPORTS ■ PUBLIC EDUCATION/INFORMATION
3100 Zinfandel Drive, Suite 600 • Sacramento, CA 95670
(916) 852 1300 • OTHER OFFICES NATIONWIDE

E & A Environmental EMCON, Inc.
95 Washington Street Suite 218
Canton, Massachusetts 02021
(617) 575-9089
Fax: (617) 575-8915
Branches in:
Minnesota
North Carolina
Washington
SPECIALISTS:
• Solid Waste
• Sludge
• Composting
• Recycling
• Land Application
• Product Marketing
• Facility Design

The Sludge Solution:
AGRICULTURAL UTILIZATION
Sludge Hauling
Pond Cleaning
Dredging
Digester Cleaning
Contamination Diving
Agricultural Use Plans
Site Management Reports
PSRP & PFRP Upgrading
Sludge Stabilization
Land Application
ENVIRONMENTAL SCIENCES CORPORATION
P.O. Box 915139
Longwood, FL 32791
(407) 682-2272

DPRA Solid Waste Consultants
Planning, Engineering, Implementation...
• Composting
• Recycling
• Waste Reduction
• Facility Design
• Market Assessment
• Waste Composition
332 Minnesota St., St. Paul, MN 55101 (612)227-6500
• Chicago • Dallas • Denver • Kansas City • Manhattan • Washington D.C

WFC
(516) 364-9890
Solid Waste Management
Resource Recovery and Recycling
Sewage and Sludge Treatment
Hazardous Waste Management
Water Supply and Treatment
William F. Cosulich Associates, P.C.
Environmental Engineers
330 Crossways Park Drive, Woodbury, New York 11797-2015

ENVIRO-GRO TECHNOLOGIES

CalRecovery INCORPORATED
725C Alfred Nobel Drive
Hercules, California 94547
Telephone: 510-724-0220
Facsimile: 510-724-1774
WASTE MANAGEMENT CONSULTANTS SINCE 1975
■ Source Reduction
■ Materials Recovery
■ Recycling
■ Composting
■ Planning
■ Engineering Design
■ Market Analysis
■ Implementation
■ International
With branch offices in Bloomington, Minnesota and New Haven, Connecticut

L.I.S. CORPORATION
14535 Dragoon Trail
Mishawaka, IN 46544
(219) 256-0204
– SLUDGE STORAGE BINS
– CARBON SOURCE SILOS AND RECLAIMERS
– BULK STORAGE AND HANDLING SYSTEMS
LAIDIG INDUSTRIAL SYSTEMS

423

Action
for a
cleaner tomorrow.

A South Carolina Environmental Curriculum

For more information about South Carolina and the environment, call the
South Carolina Department of Health and Environmental Control at
1-800-768-7348.

Ins & Outs of a Worm's Life

Preparation Time: Easy-To-Do Moderate **Extensive**

Grade: 6 – 8
Focus: Household waste, waste reduction, composting
Subject: Science
Materials: See list
Teaching Time: Extensive ongoing project
Vocabulary: Anaerobic, worm castings, biodegradation, composting

Learning Objective

Students will:

- discover a beneficial, low technology way to reduce household waste
- understand the natural process of **biodegradation** and soil production
- see how to improve soil through worm composting
- learn what a landfill does
- learn the benefits of composting.

Background

In South Carolina, food waste constitutes 6.7 percent of the solid waste stream. *(Source: South Carolina Solid Waste Management Plan, 1994, S.C. Department of Health and Environmental Control.)*

When we throw food scraps into the garbage, we turn a resource into a liability. At significant financial and environmental cost, waste has to be picked up, transported, and buried or burned. Composting our kitchen waste provides an alternate use for kitchen waste and creates rich soil.

Redworms, *Eisenia foetida*, in backyard worm bins are used to process kitchen waste into high quality garden compost. NOTE: Properly constructed and maintained, worm bins *do not* give off an offensive odor. For more information on earthworms, see the article "Getting Earnest About Earthworms," by Richard Conniff, *Smithsonian* Magazine, July 1993.

Worm bins provide the following benefits:

- reduce household waste
- save garbage disposal costs
- produce an excellent soil amendment
- provide worms for fishing
- demonstrate one of the most important natural processes: biodegradation and soil production.

Materials to make a composting worm bin

- Wooden box (24" x 42" x 16") (61 cm x 106.5 cm x 40.5 cm) Although construction plans for this box are included with this lesson, alternatives include using a polystyrene ice chest or an apple crate with screen covering the inside of the box or any container in which you can drill holes
- Paper
- Water

DOWN TO EARTH

On average, an acre of land contains more than 3 million earthworms. And every gram of compost contains a billion organisms.
Source: *50 More Things You Can Do To Save The Earth*

- Dirt
- Redworms (*Eisenia foetida*)
- Calcium carbonate (egg shells)
- Food waste (no meat or meat by-products!)

Learning Procedure

1. Ask the school's shop class to build a 24" x 42" x 16") (61 cm x 106.5 cm x 40.5 cm) wooden box. See the construction plans included with this lesson. OPTION: Select a similar sized alternative box such as an apple crate or heavy shipping carton. You can use wood, metal, or other containers, as long as they are not filled deeper than 12 inches. A piece of heavy duty plastic may be used as a cover.

Nine to 12 holes should be drilled into the bottom and sides of the box. The holes provide air for the worms. A cookie sheet or plastic layer should be placed under the box to catch any debris or water falling through the holes.

2. Discuss with the class the impact of food wastes on the solid waste stream. Discuss alternative methods of handling food wastes. Introduce the idea of using redworms (*Eisenia foetida*).

3. You will need one pound (454 g) of redworms for the bin. Ask the students to look for and collect redworms (not nightcrawlers). Hints for where to look: barnyards under mulch, in compost piles, under decomposing lumber. You may need to supplement the red worm find by obtaining some from a commercial grower. Look in the *Yellow Pages* under Agricultural Suppliers.

4. Set up your worm bin. For a 4-cu.ft. (1 cubic meter) bin, bury four pounds of food waste in the bin each week, making sure to rotate the location of the burial *(mentally dividing the bin into nine squares would probably be helpful).*

Generally, for worm bins, *for each cubic foot (cubic meter) of bin*, you need 1.5 pounds (680 g) of bedding, 1 gallon (± 3.5 liters) of water, 1 pound (454 g) of garbage per week, 4.5 ounces (128 g) of redworms, a bit of soil, and calcium carbonate. For a 4-cu.-ft. (1 cubic meter) worm bin you will need:

- 1 box filled no deeper than 12 inches (to prevent **anaerobic** conditions from developing)
- 1 room or space with a temperature between 55°F and 77°F (13°C and 25°C)
- 6 pounds (2.7 kg) of paper for bedding
- 1-2 handfuls of soil (optional)
- Several eggshells
- 1 pound (454 g) of *Eisenia foetida* (redworms)
- 4 pounds (1.8 kg) of food waste per week

Half-size bins are also effective; they require half the amount of food and materials.

5. Shred the paper by tearing it into strips about 2-inches (5 cm) wide. Put the paper in a bucket, and slowly pour water in while fluffing the paper occasionally. Let the paper segments drip until dripping subsides. Put wet strips of paper in the worm box, and sprinkle in several eggshells (for worm reproduction).

6. Gently place the worms in the box, leaving the top open until the worms burrow down. Close the lid or cover with a black plastic sheet. *(Since worms do not react to red light, a red plexiglass side panel or lid would allow direct observation of worm activity.)* Bury food in the box each week, rotating the burial location.

Some of the foods that will work well in the worm bin are bread, corn stalks, egg shells (a good source of calcium carbonate), grass clipping, leaves, saw dust, spoiled fruit and vegetables, vegetable peelings, clothes dryer lint, citrus rinds, evergreen needles, hay or straw, twigs, weeds, coffee grounds, discarded houseplants and flowers, manure, garden waste, hedge clippings, used potting soil, and wood chips.

Avoid putting plastic, bottle caps, rubber bands, sponges, aluminum foil, or glass in the box. Fruit flies can be avoided by burying the food waste completely.

7. The worm bin needs little routine maintenance. Depending upon the desired outcome, the bedding should be changed every three to six months. After three months, one will find the number of redworms is high; after four months, the number of redworms

will still be high, and the quality of compost will be fairly good; after six months, many redworms will have died, but the quality of the compost will be very good. The resulting compost will be primarily **worm castings** (worm manure).

To change worm bedding, either dump the contents of the bin under a bright light and brush the layers of compost away *(the worms will move away from the light and gather at the bottom of the pile)*; or pull the compost plus worms to one side of the bin and add new bedding to the vacant side.

A simple alternative is to use only one-half of the box at a time; put your bedding and worms in one side of the worm bin. Continue to bury food into the bedding until it is composted. Then add new bedding to the empty half of the bin. Begin burying food on the new side.

8. Allow one month for the worms to migrate to the new side. Remove the worm castings. Repeat the process. To be certain you have all the worms from the first side, expose the worms to bright light, then wait 20 to 30 minutes. Remove the top layer until worms are exposed. Repeat until the worms are in a mass in the center of the old bedding, then add the mass of worms to new bedding. Use the soil formed by the castings on potted plants or in the garden.

Questions for the Class
1. What are worm castings?
2. How many ounces or pounds of worms, bedding, water and food waste do you need for each cubic foot of a worm bin?

Extension Activities
1. Study the reactions of worms to different colors of light. Study the food preferences of young versus mature worms. Using four worm bins, study the reactions of the worms to the four food groups.

2. Study the other organisms present in the worm bin. What is the interrelationship of these organisms?

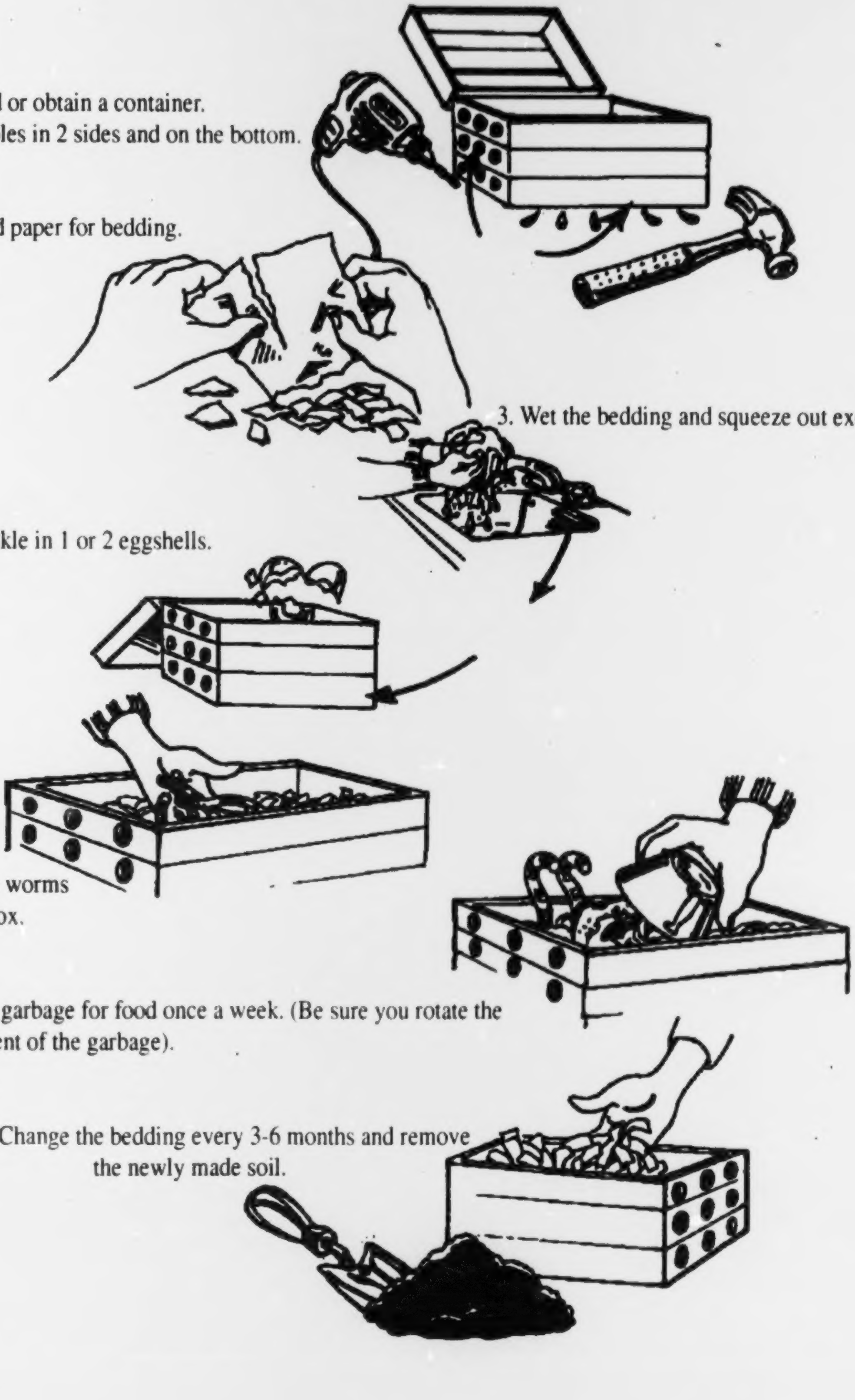
3. Study the effects of various mixtures of vermicompost, peat moss, soil, and perlite on potted pants.

4. Calculate how much food the households of class members throw away in a day. Base the calculation on the fact that each South Carolina resident produces about 5.6 pounds (2.52 kg) of garbage in the home per day. *(Source: South Carolina Solid Waste Policy and Management Plan.)*

5. Discuss: Why, in a hungry world, do we throw away so much food? In South Carolina, 6.7 percent, approximately 370,000 tons, of our total solid waste stream (5 million tons) is food. *(Source: South Carolina Solid Waste Management Plan, 1995, S.C. Department of Health and Environmental Control.)*

Just Do It

Read more about composting
and try it at home.



1. Build or obtain a container. Drill holes in 2 sides and on the bottom.

2. Shred paper for bedding.

3. Wet the bedding and squeeze out excess water.

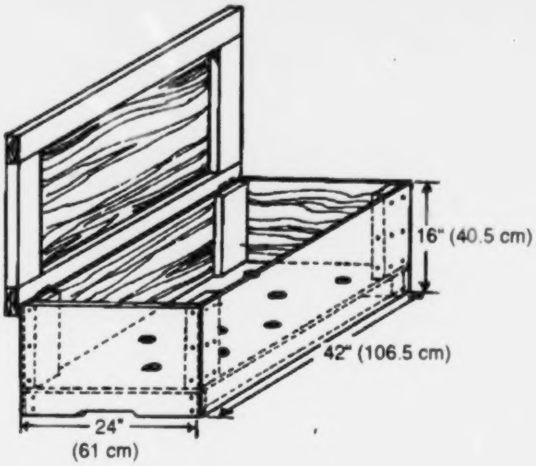
4. Sprinkle in 1 or 2 eggshells.

5. Place worms in the box.

6. Bury garbage for food once a week. (Be sure you rotate the placement of the garbage).

7. Change the bedding every 3-6 months and remove the newly made soil.

1-2-3 Worm Composting Bin



This system is designed for composting vegetable food wastes using red worms. Food wastes and worms are "bedded" in shredded and moistened newspaper, cardboard, peat or brown leaves. The worms turn both food wastes and bedding into a high-quality compost suitable for use on house plants, seedlings or general garden use.

To maintain this system, simply rotate food wastes throughout the bin. Every 3-6 months the compost should be moved to one side of the bin and new bedding added to the empty half. At this time, start burying wastes in the new bedding only. Within one month worms will populate the new bedding, finished compost then may be harvested and the rest of the bin can be rebedded. During the winter, worm bins should be kept in a cool indoor space such as a basement or warm garage to avoid freezing. A properly maintained worm bin is odorless. Bins may be placed in a shady outdoor space the remainder of the year. Flies may be controlled by placing a sheet of plastic over the bedding.

This bin can be built for about $35 with new wood and hardware, or less using recycled materials. Worm bins can also be made from wooden boxes or other containers. Any worm bin must have drainage in the bottom and a tight-fitting lid to keep moisture in and pests out. A starter batch of worms can be purchased at a small additional cost, or find some in an old compost pile.

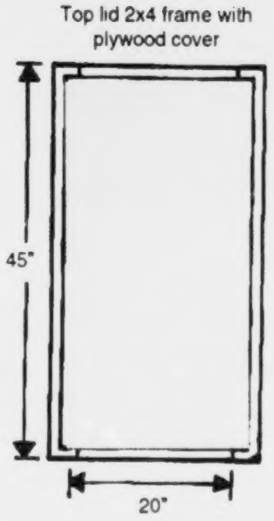
Materials

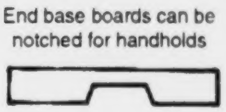
one sheet of treated 1/2" (1.3 cm) plywood
one 12 foot 2" x 4" (3.7 m x 10 cm)
one 16 foot 2" x 4" (5 m x 10 cm)
2 lbs. (9 kg) of 6d galvanized nails
1/2 lb. (2 kg) of 16d galvanized nails
2 galvanized door hinges

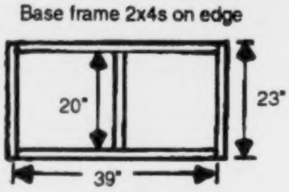
Tools

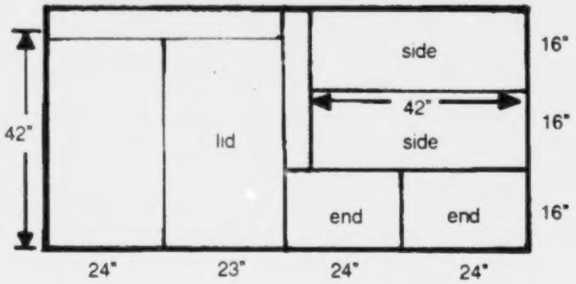
Tape measure, skill saw or rip hand saw, hammer, saw horses, long straight edge or chalk snap line, screwdriver, and drill with 1/2" (1.3 cm) bit.
Use eye and ear protection.

Construction Details


Top lid 2x4 frame with plywood cover
45"
20"


End base boards can be notched for handholds


Base frame 2x4s on edge
20"
23"
39"


42"
lid
side
42"
side
end
end
16"
16"
16"
24"
23"
24"
24"

Measure and cut plywood as indicated in drawing above. Cut the 12 foot 2" x 4" into five pieces: two 39", two 23", and one 20" long. Nail the 2" x 4"s together on edge with two 16d nails at each joint as illustrated in the Base Frame diagram. Nail the plywood base piece onto the 2" x 4" frame.

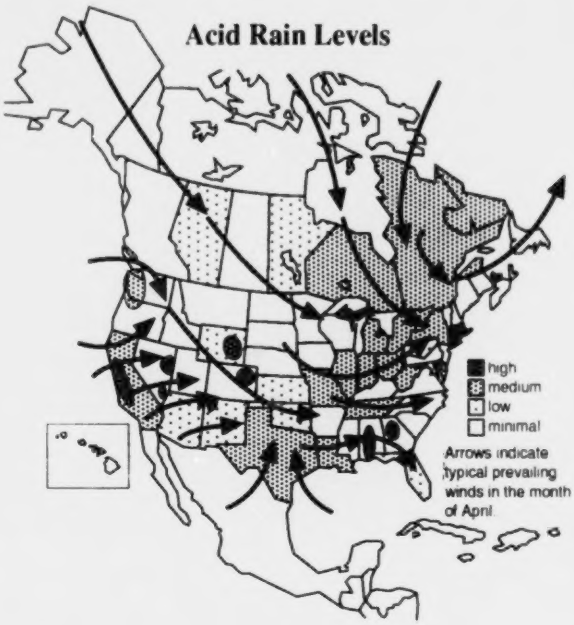
Cut four 1-foot lengths out of the 16 foot 2" x 4". Take each plywood side piece and place a one-foot 2" x 4" under each of its ends so that the 2" x 4" is flush with the top and side edges of the plywood, and nail the boards into place. Nail the side pieces onto the base frame. To complete the box, nail the ends onto the base and sides. To reinforce the box, be sure there is a nail staggered at least every 3 inches wherever plywood and 2" x 4"s meet. Drill twelve 1/2" holes through the bottom of the box for drainage.

To build the lid, take the remaining 12-foot 2" x 4" and cut it into two 45" pieces and two 20" pieces and lay them flat, short pieces on the inside as indicated in diagram above, so that the plywood top is inset from the edges of the 2" x 4" by 1-1/2" all the way around the perimeter. Nail the plywood onto the 2" x 4"s, and on the underside of the 2" x 4" lid frame, so that the lid will stand upright when opened.

"I'm Melting!"

Preparation Time: Easy-To-Do Moderate **Extensive**

Grade: 6,7 & 8
Focus: Acid Rain
Subject: Science, Math, Geography
Materials: See list below.
Teaching Time: Several class periods
Vocabulary: dry fallout


Acid Rain Levels
■ high
▨ medium
▤ low
☐ minimal
Arrows indicate typical prevailing winds in the month of April

Learning Objective
Students will:

- determine how acidity and pH relate to acid rain and its effects on different materials.

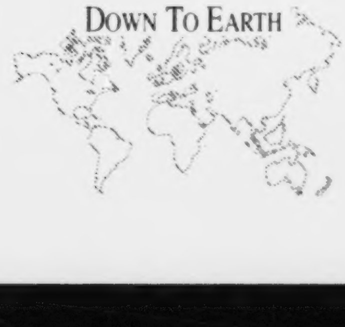
Background
Acid rain is caused by the conversion of sulfur oxides and nitrogen oxides in the upper atmosphere into sulfuric and nitric acid. These acids are formed when the oxides combine with moisture in the atmosphere. They then fall to earth during precipitation in the form of rain, snow, fog and "**dry fallout**."

The major sources of sulfur oxides are coal-burning power plants and industrial boilers. Nitrogen oxides also come from coal-fired boilers and automobiles. In North America, the areas most sensitive to acid rain are those where acid rain falls on shallow soils and granite bedrock. Lakes that lack the ability to buffer, or neutralize, the acid are also in danger.

Acid rain has many damaging effects including killing animal life in lakes and harming vegetation. This produces a threat to people as well. In addition, many buildings and monuments made from granite and limestone are "eaten away" over time by acid rain.

This is not a new problem and there are some solutions to the acid rain problem. While this used to be a local problem in areas downwind of power plants and industrial facilities, the use of tall smokestacks sends the pollutants high into the atmosphere where weather patterns spread the pollutants over much of North America. In fact, a portion of South Carolina's air pollutants are from the Midwest and Ohio Valley regions. Coupled with the propensity for stagnant weather patterns over much of the state in the summer months, and you'll soon realize why many lazy summer days in South Carolina are hazy as well. Although this haze is from ozone in the atmosphere and has little to do with acid rain, it is a prime example of how airborne pollutants travel long distances.

The rain falling over the eastern United States and neighboring areas of Canada is 10 to 100 times



The Friends of the Boundary Waters Wilderness is a Minnesota-based environmental organization. They were instrumental in the passage of state acid rain legislation in the early 1980s. These became the strongest acid rain standards in the world.

The Information Please Environmental Almanac, 1993

more acidic than normal. There are some storms in which the rainfall is 1,000 times more acidic. The most cost-effective, and only reliable solution to the acid rain problem, is to control the offending pollutants at their source. The goal is to emit fewer sulfur oxides and nitrogen oxides into the air so that fewer acids form in the atmosphere. Sulfur and nitrogen oxides are formed as a byproduct of combustion and are introduced into the air at high altitudes by tall smokestacks. When these oxides mix with water in the air they form acids and are introduced into the ecosystems and fall on buildings when it rains.

Plants, animals, ponds and rivers require a delicate balance of pH in order to sustain life. Acid rain can knock that pH out of balance. Buildings and statues are often made of materials such as granite, marble, limestone and copper. Acids cause these materials to deteriorate.

Acid rain varies from one rainfall to the next. In South Carolina you might record a rainfall with a pH of 6.5 one week and it might be 4.2 the next. It should be noted that rainfall is naturally slightly acidic due to the presence of carbon dioxide. However, many factors determine the pH of rain, including the level of airborne pollutants, the type of pollutants and where they came from, how often and how much it has rained since those pollutants were introduced into the atmosphere as well as wind patterns and wind speed.

Materials

- pH paper with a color indicator chart, beakers or jars (baby food jars will work, too)
- a variety of substances such as vinegar, ammonia, tap water, rain water, groundwater, soda, lemon juice and baking soda dissolved in water (choose substances with pHs above and below 7)
- for each group, one item for each of the jars: chalk, marble chip, and pennies (because of changes in the copper content of pennies, make sure the pennies used in this lesson were minted prior to 1983).

Learning Procedure

1. Share the Background material with the class. Discuss deforestation of the Black Forest in Germany due to acid rain. Note that the South Carolina State House is being renovated. The green dome will be replaced with a new copper dome. Eventually that new dome will turn green. Why? Although the oxidation of copper (turning green) is natural, acid rain hastens this process.

2. Place each substance into a separate jar. Using the pH paper, determine the pH value for each substance. For a control, place plain water in one jar.

3. Place the jars in order or acidity or alkalinity. Note the name of the substance and the pH on each jar.

4. Place in each jar a marble chip, a piece of chalk, and a penny and note your observations.

5. Let the jars sit undisturbed for 48 hours. After 48 hours, look at the items and note any changes in their appearance. Compare the results for the different substances.

6. It may take longer for the substances to affect the penny. Let the substances sit for five days and repeat the observations.

7. The next time it rains, collect some rain water. Do not collect drips from the roof or downspout. Check the pH of the rain water. Where does it fall in comparison to your substances in your jars? Note that the pH of rain may vary widely from rainfall to rainfall.

Questions for the Class

1. Which items were the most affected?

2. What was the pH of the substance that affected the items the most?

3. How does adding acidic and alkaline compounds change water quality?

Extension Activities

1. Have students research the effects of acid rain on well-documented historical structures. Both the U.S. Capitol and the Statue of Liberty have recently undergone extensive renovations to correct damage caused, in part, by acid rain. Remember: due to the natural occurrence of CO_2 rainwater is slightly acidic anyway.

2. Perform the following experiment to test various water samples for the presence of carbon dioxide (CO_2):

Materials

200 ml beaker
2 eye droppers
phenolphthalein (Use with caution. This substance is flammable. Keep away from open flame.)
sodium carbonate (Na_2CO_3) solution
3 different samples of water labeled A,B, & C
safety glasses

Procedure

1. Pour 100 ml of Water Sample A into a beaker.

2. Add 10 drops of phenolphthalein into the water sample. Swirl GENTLY. Note: if a light pink color appears, wait one-minute. If the pink color remains, the sample has no CO_2 gas present. Record this as "zero" on a data chart.

3. If no pink color appears, measure the CO_2 present by doing the following:

a: Using an eye dropper, add sodium carbonate to the solution ONE DROP AT A TIME. Swirl GENTLY.

b: Count the number of drops of sodium carbonate needed to form a light pink color in the water sample. Note: A light pink color may form and then disappear in a few seconds. Keep adding drops of sodium carbonate only until the pink color remains.

c: Record the number of drops used in the data chart.

4. Rinse the beaker well.

5. Repeat Steps 1 through 4 with Sample B.

6. Repeat Steps 1 through 4 with Sample C.

Ask: Where does CO_2 come from in nature? How does CO_2 get into rivers, lakes, etc.? How do lakes, rivers or streams become polluted?

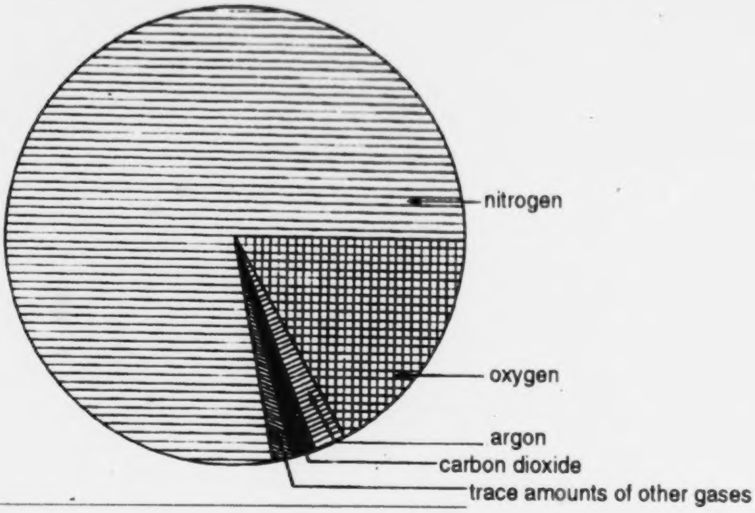
Data Collection Chart

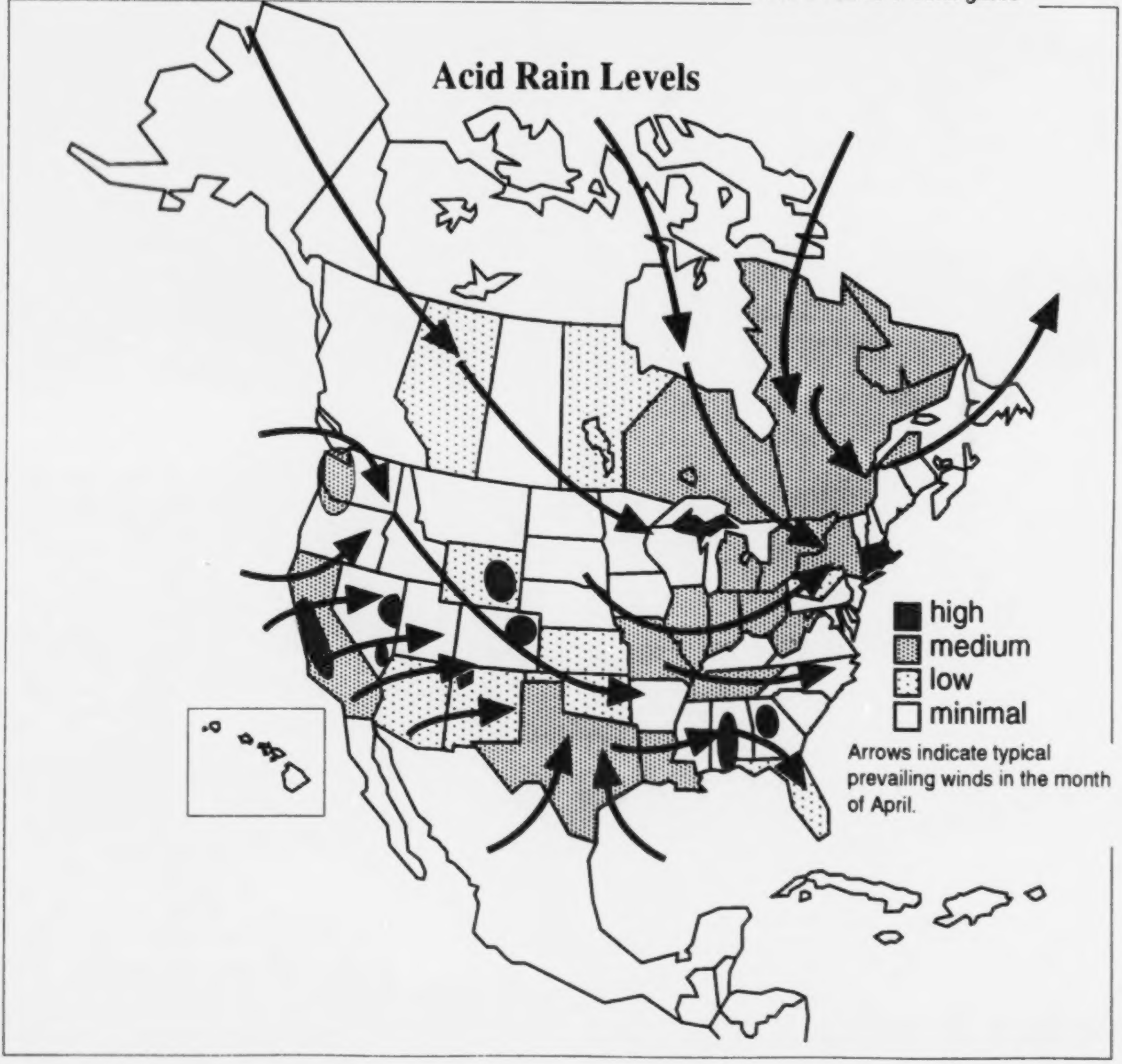
WATER SAMPLE	NUMBER OF DROPS OF Na_2CO_3 ADDED
A	
B	
C	

Just Do It

Note weather patterns that blow into South Carolina. Pay attention to where this "new" wind has been and then look at the economies of the states that are "up-wind" from South Carolina. What kind of pollutants do we add to this wind and send downwind? Who - or what - is downwind from South Carolina?

The Make-up of Air.




Acid Rain Levels

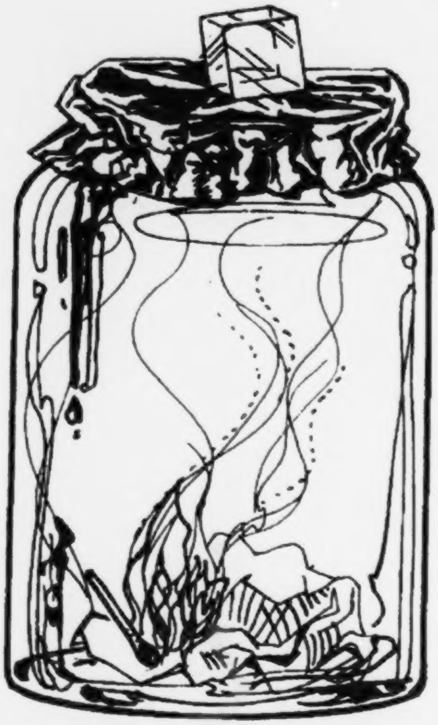
▇ high
▨ medium
░ low
☐ minimal

Arrows indicate typical prevailing winds in the month of April.

The Ozone or the No-Zone?

Preparation Time: Easy-To-Do Moderate **Extensive**

Grade: 6,7 & 8
Focus: Ozone
Subject: Science, Math, Health
Materials: Clean, wide-mouthed jars with lids (mayonnaise jars work well), heavy aluminum foil, ice. NOTE: You may wish to work in groups and will need enough materials for each group.
Teaching Time: One class period
Vocabulary: smog, ozone, CFCs



Learning Objective

Students will:

- understand the affect rising pollution levels have on the creation of ozone and on the ozone layer
- understand the difference between ground-level and stratospheric ozone layers.

Background

Ozone is a form of oxygen consisting of three oxygen atoms linked together. Ozone is considered to be both helpful and harmful. Chemically, ozone is ozone. In other words, ground-level ozone and stratospheric ozone are the same substance. Whether or not it is helpful or harmful depends on where it is.

"Good" ozone in the upper atmosphere (the "ozone layer") occurs naturally and protects life on earth by filtering out ultraviolet radiation from the sun. Ultraviolet radiation, among other things, produces sun tans, sun burns and, in extreme cases, can lead to skin cancer. The good ozone blocks much of the ultraviolet radiation from entering the atmosphere and reaching the surface of the Earth.

Ozone at ground level, "bad ozone," is a noxious pollutant. It is the major component of **smog** and presents this country's most stubborn urban air quality problem. Ozone is a severe irritant. It is responsible for the choking, coughing, and stinging eyes associated with smog. Ozone damages lung tissue, aggravates respiratory disease, and makes people more susceptible to respiratory infections. Children are especially vulnerable to ozone's harmful effects, as are adults with existing respiratory diseases. But even otherwise healthy individuals may experience health problems from breathing ozone-polluted air.

High ozone levels also inhibit plant growth and can cause widespread damage to crops and forests.

DOWN TO EARTH

Texas releases more toxic materials into the air than any other state — about 170 million pounds. Tennessee is second.

The Information Please Environmental Almanac, 1994.

Unhealthy ozone levels are a problem across the United States, with nearly 100 cities exceeding the U.S. EPA's National Ambient Air Quality Standard. The standard is based on the highest ozone exposure sensitive persons can tolerate. Nine cities, home to 57 million people, are considered "severely" polluted, experiencing peak ozone levels that exceed the standard by 50 percent or more. In South Carolina, all major metropolitan areas meet the federal ozone standards. However, increases in population and motor vehicle travel could lead to problems, especially if automobiles are not properly maintained and factory-installed emissions control equipment does not work properly.

Automobiles are the major source of ozone-producing pollutants. Ozone itself is not produced directly by automobiles, but is formed in the atmosphere through a series of chemical reactions involving hydrocarbons, nitrogen oxides, and sunlight. How fast and how much ozone is produced is related to both temperature and intensity of the sunlight. Because of this, high ozone levels usually occur most on hot summer afternoons. In South Carolina, the highest ozone levels generally peak in the mid- to late-afternoons, coinciding with the day's highest temperature. Generally, ozone levels are high between April and October, with May through August being the peak months.

While automobiles are the major contributors of the ozone-producing pollutants, hydrocarbons and nitrogen oxides also come from many industrial and combustion processes. However, in typical urban areas, at least half of those pollutants come from cars, buses, trucks, and off-highway mobile sources such as construction vehicles and boats.

The Clean Air Act of 1970 gives primary responsibility to state and local governments for regulating pollution from power plants, factories, and other "stationary sources." EPA has primary responsibility for regulating "mobile sources," which include cars, trucks, buses, and aircraft.

The EPA vehicle emission control program has achieved considerable success in reducing both nitrogen oxide and hydrocarbon emissions. Cars coming off today's production lines typically emit 76 percent fewer nitrogen oxides and 80 to 90 percent fewer hydrocarbons over their lifetimes than their uncontrolled counterparts of the 1960s. The improvement is a result of strict regulations that require auto manufacturers to develop catalytic converters, systems capable of capturing excess gasoline vapors and cleaning tailpipe emissions.

Ground-level ozone in many cities has decreased with the introduction of unleaded gasoline and as newer cars with improved emission control systems continue to replace older models. Although there has been significant progress since 1970 in reducing emissions per mile traveled, the number of cars on the road — and the miles they travel — has almost doubled in the same time frame.

A second reason that ozone levels remain high is that emission control systems do not always perform as designed over the full useful life of the vehicle. Routine aging and deterioration, poor maintenance, and emission control tampering can increase vehicle emissions. In fact, a major portion of ozone-forming hydrocarbons can be attributed to a relatively small number of "super-dirty" cars whose emission control systems are not working properly.

Unless we dramatically reduce the amount of pollution vehicles actually emit, or drastically cut back on the amount we drive, smog will continue to exist in many cities.

EPA believes controlling ground-level ozone-causing pollutants such as hydrocarbon and nitrogen oxide emissions is the most promising strategy for reducing ozone levels in most urban areas. Toward that end, the federal government will establish more stringent limits on gasoline volatility, control hydrocarbon vapors that evaporate during vehicle refueling, tighten tailpipe emission standards, and require improvements in inspection and maintenance programs. EPA also is developing requirements for "warning systems" on all cars to alert drivers when the emission controls malfunction.

In the most polluted cities, however, these measures will not be sufficient. The only way to ensure healthy air is to markedly reduce our use of cars or to switch to fuels that are inherently cleaner than conventional gasoline. Using these alternative fuels means substituting methanol, ethanol, or natural gas for conventional gasoline. Using electricity would result in somewhat greater reductions in ozone-forming hydrocarbons; propane, in somewhat smaller reductions; and reformulated gasoline, in considerably smaller reductions, relative to methanol, ethanol, or natural gas fuel.

Stratospheric ozone, on the other hand, is yet another tale. The so-called "good" ozone exists 12 to 30 miles (19 to 48 kilometers) above the earth and it resides in the stratosphere. In the upper levels of the atmosphere, ozone forms a protective layer that blocks ultraviolet rays from the sun.

This protective layer of "good" ozone is being depleted by a family of chemical compounds known as chlorofluorocarbons, or **CFCs**. CFCs are very stable compounds that last a long time. Once they are released into the atmosphere, CFCs remain CFCs and don't easily break down into their component elements, two of which are chlorine and fluorine. CFCs drift into the upper atmosphere — it can take decades for this to happen — where the CFCs are broken down by the sun's ultraviolet rays, releasing the chlorine and the fluorine which then destroys the protective ozone layer.

Any ozone-depleting material released today will destroy the ozone layer many years from now. One CFC molecule can destroy 100,000 ozone molecules. It's easy to see why ozone is disappearing much faster than nature replaces it.

CFCs, under the Clean Air Act of 1990, are being phased out of use in aerosol cans, air conditioners and refrigerators. It is currently illegal to release all refrigerants into the atmosphere. Other ozone-depleting substances include solvent cleaning products, refrigeration and air conditioning fluids, foam products such as polystyrene, aerosols, and other products such as halon which is used in some fire-suppressant systems.

Learning Procedure

1. Explain that the class will be making artificial smog in a jar. Remind them that this is only a demonstration, and they will only be replicating the *appearance* of smog, not the actual make-up of smog or its effects. Remind them that smog is *not* smoky fog.

2. Cut a strip of paper about 6 inches x 2 inches. Fold it in half and twist it into a rope-like shape.

3. On the top of the jar, form a snug lid for the jar using aluminum foil. Make a small indentation to keep the ice cubes from sliding off. Carefully remove the foil lid and set it aside.

4. Put a little water in the jar and swirl it around to wet the inside of the jar. Pour off any excess water.

5. Light the paper and drop it and the match into the jar. Quickly put the foil lid in the jar and seal it tightly. Place the ice on the lid to make it cold so that the water vapor in the jar will condense. This step must be done very quickly so the students may need some help.

6. Have the students record their observations. Does this look like real smog? What is the "smog" in the jar made of? (water vapor, soot particles, carbon dioxide and other vapors)

Questions for the Class

1. Ask students to identify trips they themselves make in cars that might be unnecessary, trips that could be eliminated, or those which could be accomplished by other means of transportation.

2. How does urban growth affect air pollution? Housing patterns? Where people live in relation to where they work, shop, go to school?

3. What are the advantages and disadvantages of mass transit? Carpooling? Taking the school bus?

4. How many cars are registered in your city? County? South Carolina? The South Carolina Department of Transportation can provide this

information and may be a good source for a classroom speaker.

5. What is a catalytic converter? How does it change auto emissions? A professional mechanic could bring a catalytic converter to class and discuss its operation.

6. South Carolina recently changed the law requiring annual safety inspections for cars. Some states still require safety inspections as well as annual emission inspections. Although we do not require emission inspections in this state and since we no longer require safety inspections, will this affect air quality in South Carolina? In the United States?

7. What are some of the alternatives to automobile transportation? *(Mass transit, bicycles, etc.)*

Extension Activity
Some fuels are inherently cleaner than gasoline because they emit fewer nitrogen oxides or hydrocarbons, and because the hydrocarbons they do emit are less likely to react in the atmosphere to form ozone. Have students research and write a report on one or more of the following alternative fuels:

- ALCOHOLS: Methanol (made from natural gas, coal, or biomass) and ethanol (made from grains or sugar) are high-octane liquid fuels. Cars designed to run on pure alcohol fuels have the potential to emit 80 to 90 percent fewer reactive hydrocarbons than advanced-technology gasoline cars.

- ELECTRICITY: Battery-powered cars have the potential for zero tailpipe and evaporative hydrocarbon and nitrogen oxide emissions, although we must still account for power plant emissions. Today's electric vehicle technology is limited, but promising recent developments may lead to more widespread use in the future.

- NATURAL GAS: Compressed natural gas is also an excellent automotive fuel, particularly for fleet vehicles where long driving range is not important. Natural gas vehicles have the potential to emit 85 to 95 percent fewer reactive hydrocarbons than advanced-technology gasoline vehicles.

- LIQUID PETROLEUM GAS (PROPANE): Propane is a byproduct of petroleum refining and natural gas production. Propane vehicles emit considerably less ozone-forming hydrocarbons than do vehicles fueled with conventional gasoline.

- REFORMULATED GASOLINE: The petroleum industry is studying ways to change refinery procedures to make a cleaner-burning gasoline. A number of "clean" gasolines have recently been introduced into the marketplace, and research is continuing to develop even cleaner fuels. Reformulated gasolines are capable of reducing hydrocarbon emissions by at least 15 percent.

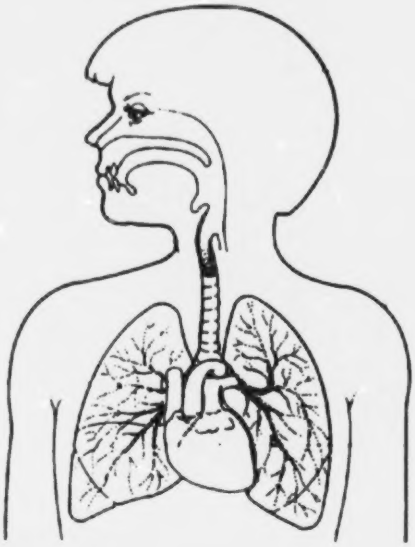
Just Do It

To fight ozone loss:
1) Service and dispose of your home air conditioner or refrigerator responsibly
2) Repair or maintain your car's air conditioner.
3) Avoid using halon fire extinguishers.
4) Choose insulation made from cellulose or fiberglass, not products containing CFCs.
5) Avoid products with methyl chloroform, also known as 1,1,1-trychloroethane which can be found in such common products as fabric protectors, spot removers, and bug sprays.

Feelin' Alright?

Preparation Time: **Easy-To-Do** Moderate Extensive

Grade: 6,7 & 8
Focus: Health effects of air pollution
Subject: Science, Health, Geography
Materials: Transparency, environmental health care professional (optional)
Teaching Time: One class period, out of class research
Vocabulary: particulates



Learning Objective

Students will:

- gain knowledge of how pollutants affect our health.

Background

Different pollutants affect our health in very specific ways. In fact, physical symptoms are often a good clue to identifying which pollutants are out there bothering people.

Prolonged exposure to these compounds can affect people in predictable ways. According to the U.S. EPA, carbon monoxide causes headaches, blurred vision and slow reflexes. Lead causes learning difficulties and alters kidney function and blood chemistry. Sulfur dioxide will cause heart and lung problems and can also harm vegetation and metals. Particulates, dust, soot, etc., can irritate the throat and cause heart and lung problems as well.

Nitrogen dioxide may cause increased respiratory illness such as chest colds and coughing, and may cause increased breathing difficulties in asthmatics. Ozone causes choking and coughing as well as irritates the eyes throat and nose.

Learning Procedure

1. Share the background material and use the transparency (included) to discuss the health effects of these pollutants.

2. Assign to the students the different pollutants and have them research their sources, which areas of the country/world have the highest concentrations, do areas without any immediate sources of these pollutants have anything to worry about?

Questions for the Class

1. Are some of these air pollutants found indoors? Outdoors?

2. How would weather affect the concentration of air pollution?

3. Which items that we deal with everyday would you be willing to live without if it would eliminate air pollution? Cars? Manufactured items? Household products?

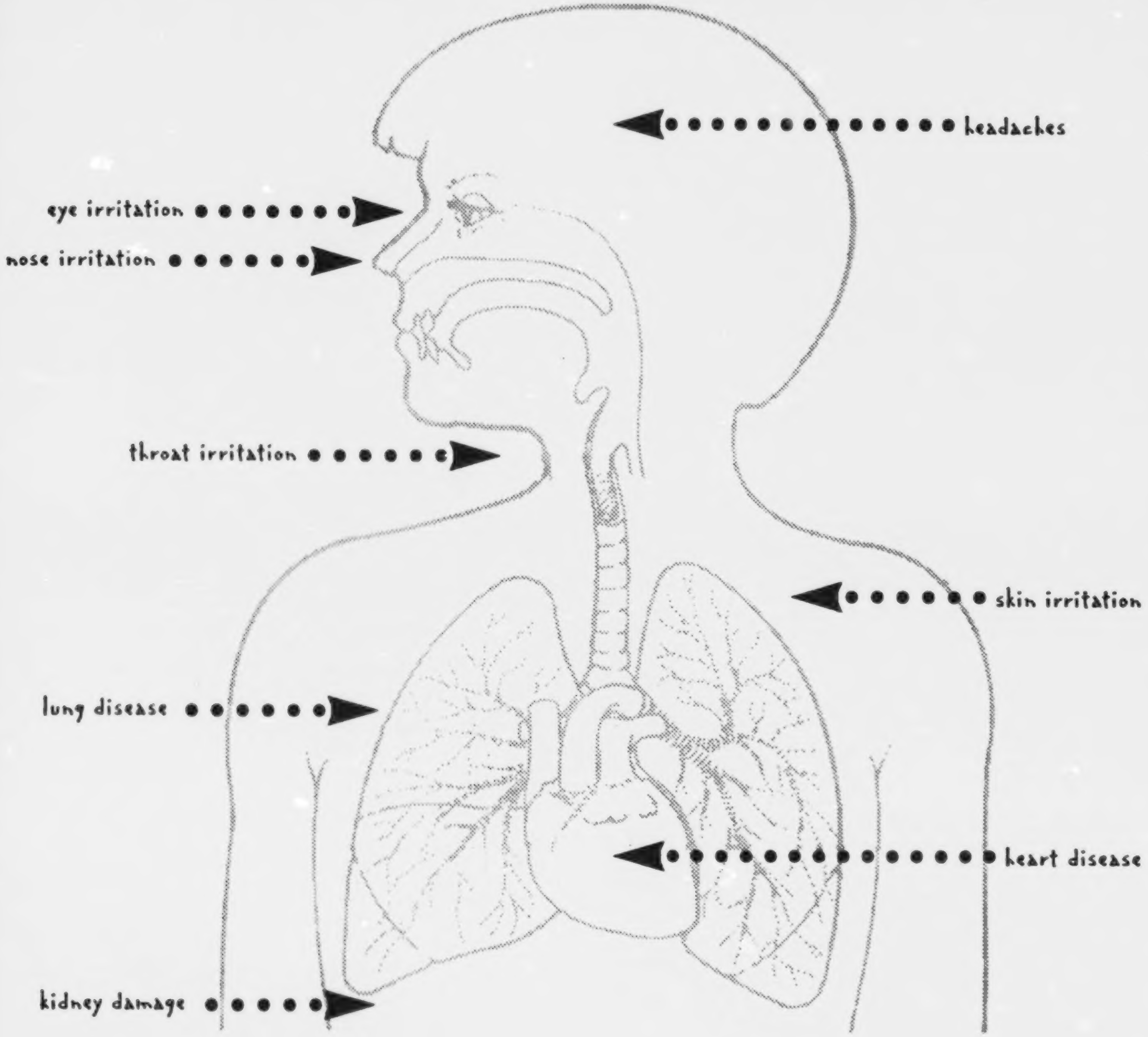
DOWN TO EARTH

The number of vehicles in use around the world is unexpected to double to around 1 billion within the next 40 years. Much of this growth will take place in developing countries where the automobile population is expected to increase by more than 20 percent by the end of the century.

The Information Please Environmental Almanac, 1993

Transparency

AIR POLLUTION & YOU


headaches
eye irritation
nose irritation
throat irritation
skin irritation
lung disease
heart disease
kidney damage

AIRBORNE PARTICULATES

- irritates your throat
- causes heart & lung problems

OZONE

- irritates your eyes, nose and throat
- causes choking and coughing

SULFUR DIOXIDE

- causes heart & lung problems
- harms vegetation and metals

CARBON MONOXIDE

- causes headaches
- causes slow reflexes
- causes blurred vision

NITROGEN DIOXIDE

- increases respiratory illness such as colds
- increases breathing difficulties in asthmatics

LEAD

- causes learning problems
- alters kidney function
- alters blood chemistry

Living in the Greenhouse

Preparation Time: Easy-To-Do Moderate **Extensive**

Grade: 6,7 & 8

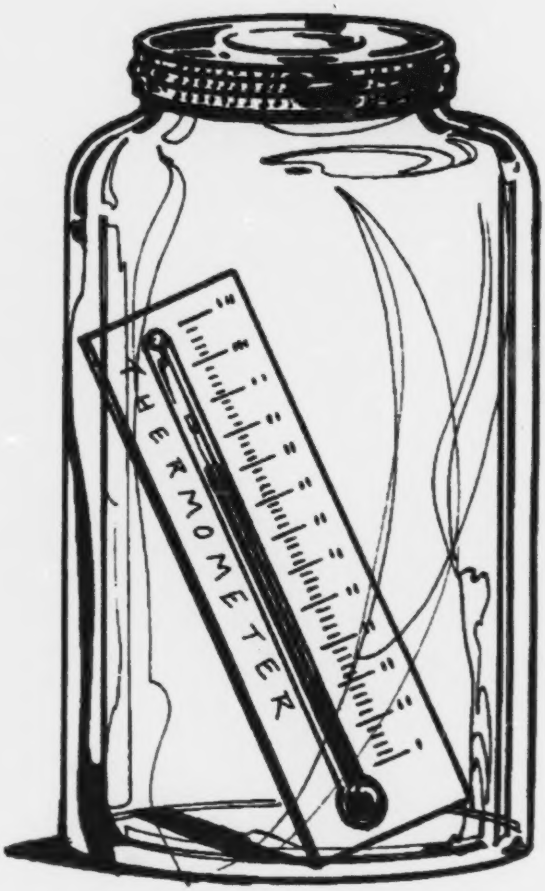
Focus: Greenhouse effect

Subject: Science, Math, Health

Materials: Clean, wide-mouthed jars with lids (mayonnaise jars work well), dark cloth or construction paper, watch with a second hand or a stop watch, meat thermometers that will fit into the jars. NOTE: You may wish to work in groups and will need enough materials for each group.

Teaching Time: Two class periods, outside

Vocabulary: greenhouse effect, electromagnetic energy, incident light wave



Learning Objective

Students will:

- understand that our atmosphere traps heat
- understand that pollutants in the air can increase temperatures that may harm the environment
- understand how human activities can cause air pollution.

Background

The **greenhouse effect** is a term that describes the trapping of heat on the surface of the Earth by the atmosphere. This is a normal event and is one of the things our atmosphere is designed to do. Without our atmosphere trapping heat, average temperatures worldwide would be about 53 degrees Fahrenheit (12 degrees Celsius) cooler, according to the U.S. EPA.

Certain air pollutants, however, magnify the atmospheric heat trapping. These gases are carbon dioxide, nitrogen oxides, methane, and CFCs or chlorofluorocarbons. CFCs are chemicals often used in air conditioners, refrigerators, and aerosol cans. The use of CFCs are being phased out and replaced with chemicals thought to be less harmful to the atmosphere than CFCs. Methane is a byproduct of the natural decay of living, or once-living, things. Nitrous oxides are the result of man-made burning and internal combustion engines such as automobiles, trucks, and buses. While there are many contributors to the greenhouse effect, many scientists believe that carbon dioxide is the most significant greenhouse gas.

DOWN TO EARTH

A warmer global climate can greatly effect polar regions. For example, in the northern polar regions, higher temperatures can result in thinner ice, as well as cause the permafrost to gradually that. this would release large amounts of methane trapped in the ice and amplify greenhouse warming.

The Information Please Environmental Almanac, 1993

Some reports show that the concentrations of greenhouse gases in our atmosphere will double over the next 100 years. This could increase our temperatures eight to 10 degrees Fahrenheit (4 to 6 degrees Celsius). There are other theories that say that increased levels of greenhouse gases in the atmosphere will increase cloud cover which will reflect sunlight away from the Earth, resulting in an overall decrease in the Earth's temperature.

Light, or **electromagnetic energy**, that reaches Earth is radiated from the sun and passes through the atmosphere to the surface where it is absorbed. Some incoming, or **incident light waves**, are reflected away by clouds or light-colored surfaces such as the polar ice caps or large snow fields.

The energy that is absorbed by the surface of the Earth is converted into heat energy that is re-radiated back into our atmosphere. This heat energy is not visible to our eyes, but can be seen in the infrared range of the light spectrum. Water vapor and carbon dioxide as well as other components of the atmosphere, especially the greenhouse gases, can not be seen by our eyes but they do react to this re-radiated heat energy, trapping the heat within our atmosphere and generally warming the surface temperature of the Earth. This is the greenhouse effect.

Deforestation contributes to the greenhouse effect by removing plant life from the oxygen production cycle. Humans produce carbon dioxide, both through burning as we have seen, and through breathing. Plants "breathe in" carbon dioxide and produce oxygen. With fewer plants available as a result of massive deforestation, carbon dioxide levels will increase.

As the population continues to escalate on the planet, more and more carbon dioxide and methane are released into the atmosphere. All of us need to be aware that our actions do contribute to the production of greenhouse gases.

Learning Procedure

1. Give each group a set of materials (jar with lid, dark cloth or paper, thermometer). Prepare the jars by placing the dark cloth inside the jar on the side. Place the thermometer on the cloth. Outside, place the jar on its side with the bottom facing the sun and the thermometer positioned so students can read it without removing it from the jar.

2. With the jar lid on, record the temperature each minute until it reaches 140 degrees Fahrenheit (60 degrees Celsius). Note the beginning temperature and how long it takes to reach 140 degrees Fahrenheit (60 degrees Celsius). Also note the ambient, or outside temperature. Is it a cloudy day or a bright sunny day?

3. Allow the jars to cool and repeat step 2, this time without the lids on the jars.

Questions for the class

1. Which jar has the fastest temperature rise? How much faster? Why?

2. How is this like a greenhouse?

3. How is this like the Earth's atmosphere?

4. What was the purpose of the dark cloth in the jar? What, on Earth, does the dark cloth represent?

Extension Activities

1. Visit a greenhouse and have the gardener talk about why it is helpful to the plants. Have the gardener discuss what could happen to the plants if it got too hot in the greenhouse. Discuss with the class how increased temperatures in the greenhouse might relate to increased temperatures in the atmosphere.

2. Repeat the experiment, this time covering the jars with aluminum foil, leaving a small window, away from the sun, to read the thermometer. Does it take longer to reach 140 degrees Fahrenheit? Why?

Erosion: Rubbing the Earth the Wrong Way

6.nps.1

Preparation Time: Easy-To-Do Moderate **Extensive**

Grade: 6 - 8

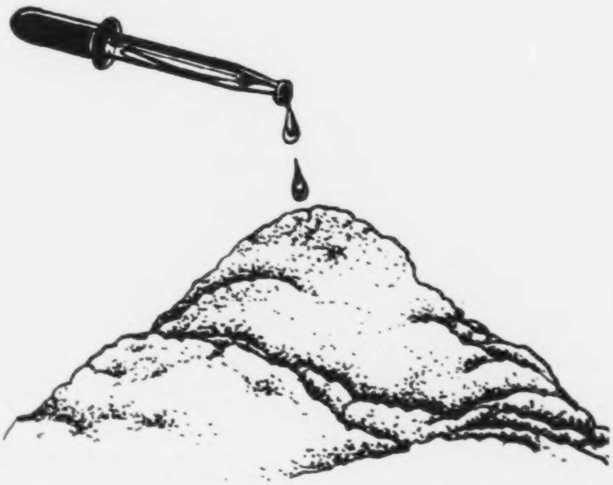
Focus: How water volume and velocity affect the erosion of soil.

Subject: Science

Materials: Sand or sandy soil, clay soil, eye dropper, 4oz. cup, 16oz. cup, water, ladder (or way to pour water from 6 feet high)

Teaching Time: Several class periods, this activity should be done outside.

Vocabulary: Erosion, sediment, pollution, turbidity, suspended solids, clarity, photosynthesis, secchi disk



Learning Objectives

In this activity, students will:

- see how erosion can cause pollution that alters the environment
- identify ways to reduce erosion.

Background

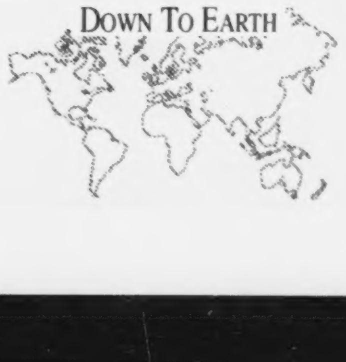
Sediment – soil particles, sands, and minerals – from land **erosion** are washed from the land through natural runoff, agricultural development, mining, and construction activities. At a billion tons a year, sediments produce the most **pollution** by tonnage worldwide. This is 700 times greater than the solids from sewage discharges.

Natural erosion rates of land, which are already high in many areas, may be increased 4 to 8 times by agricultural development, 10 to 50 times by careless construction. Enough topsoil erodes away each year to fill 18 freight trains, each long enough to reach around the entire world.

Sediment fills stream channels, harbors, and reservoirs, reduces fish and shellfish populations, erodes hydroelectric equipment, and reduces the amount of light that reaches aquatic plants.

Turbidity is the term for **suspended solids** that decrease the ability of sunlight to penetrate the water. Common causes of turbidity include plankton and soil particles. Many streams are being affected by increased turbidity due to construction, logging, mining, and improper agricultural practices. In clear water, light travels in a straight line; the particles in turbid water cause light to scatter.

For fish and aquatic animals, changes in turbidity can drastically alter the environment. Fish may be largely unaffected by slight reductions in clarity because of floating algae. However, an equal reduction in **clarity** caused by soil particles could affect fish health by irritating the gills.



In Africa, Mozambique's mangrove forests – which comprised 48 percent of the coastline, have been reduced 70 percent over the last 20 years. Loss of these forests makes coastlines more vulnerable to erosion, adversely affecting marine populations.
source: *1994 Environmental Almanac*

Aquatic fauna (animal life) are adversely affected by turbidity that directly causes suffocation or abrasion; impairs successful reproduction and development of eggs and larvae; weakens their survival rate by making them more susceptible to disease; lowers the abundance of available food; or changes natural habitats and movements.

When turbidity increases (more siltation in water), plant growth is reduced. When the photic zone — the zone illuminated by sunlight — is decreased, **photosynthesis** by plants will also decrease and limit the available food supply.

Newly constructed ponds are often treated for turbidity (muddy waters) by adding gypsum. Frequent or enduring muddiness requires a long term solution such as stream bank stabilization, or vegetative cover, plus controlling the quality of the runoff into the pond.

A **secchi disk** is a large disk used to test for turbidity. The disk can be made of fiberglass, wood, metal, etc. It should be 20 cm in diameter and divided into four sections with each section alternating black with white. A hole is left in the middle of the disk so that a rope may pass through the disk. A weight is added to the underside of the disk to make it sink in the water. The disk is lowered into the water until it disappears from sight and is then raised slowly until it is just visible again. The distance halfway between the points of disappearance and reappearance of the disk is taken as the secchi depth. The secchi depth of muddy streams will fall between 0 and 2 meters but may be as great as 40 meters in a very clear lake.

Learning Procedures

1. This activity takes place in two sessions. The first activity is to build two mounds of soil – each 2 feet high – one from sandy soil, one from clay soil.

2. Drop 10 drops of water from an eyedropper from 2 feet onto both mounds of soil. Have students observe any marks made by the water.

3. Repeat process from 6 feet. Have students observe any marks made by the water.

4. Pour 4 oz. of water onto each mound from one foot above. Have students observe any marks made by the water.

5. Pour 4 oz. of water onto each mound from from 6 feet. Have students observe any marks made by the water.

6. Pour 16 oz. of water onto each mound of soil from one foot. Have students observe any marks made by the water.

7. Pour 16 oz. of water onto each mound of soil from six feet. Have students observe any marks made by the water.

8. The second portion of this activity is to find places close to school where this type of erosion has occurred. **Note:** Notice the little ditches under roofs, erosion at the end of cement in drainage ditches, and the sides of a parking lot.

Questions for the Class

1. Have the class list three examples of this type of erosion. Discuss how, with some forethought, this problem can be helped.

Just Do It

Look for erosion and sources of runoff around your home. Consider planting greenways around your home to reduce runoff.

Extension Activities

1. Have students make their own secchi disk and test various water sources for clarity.

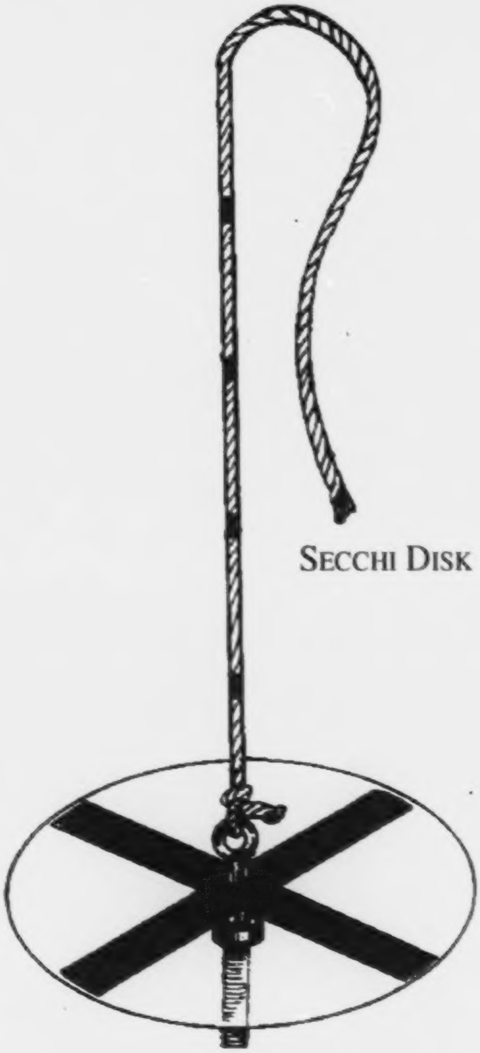
Discuss with the class how turbidity from siltation effects streams. What do plants need for growth? — one answer should be light. Do underwater plants need light too? — yes. What happens if those plants can't get enough light? — they die, which means less food and cover for many animals, etc. Young and otherwise vulnerable creatures find protection in beds of underwater plants. These plants feed and protect many types of the marine life that we eat. Can you name some? — fish, crabs and other seafoods: many people also eat ducks and geese, etc.

Have the students brainstorm sources of sediment. Try to use specific examples that they have seen in the area or at home.

This activity uses a secchi disk to measure depth of light penetration or turbidity. The deeper the disk is visible, the less turbid the water. Secchi disks should be used in water that is fairly deep and slow or still.

Materials:

- Sources of clear and muddy waters (outside or created inside in aquariums or coolers)
- Black and white waterproof paint (spray paint works well, only white paint is needed with old record albums)
- 20 cm diameter disk made of wood or old record albums or paint can lids at least 6 - 8" in diameter
- Drill or ice pick (to make center hole, do not need if you use old record albums)
- Lead weights (fishing weights work well)
- Rope/ heavy string
- Tape measure
- Large eye bolt and nut
- Paper
- Black permanent markers
- Lamination (if available, this allows students to try out a paper secchi disk)
- Old record albums that do not have to be returned



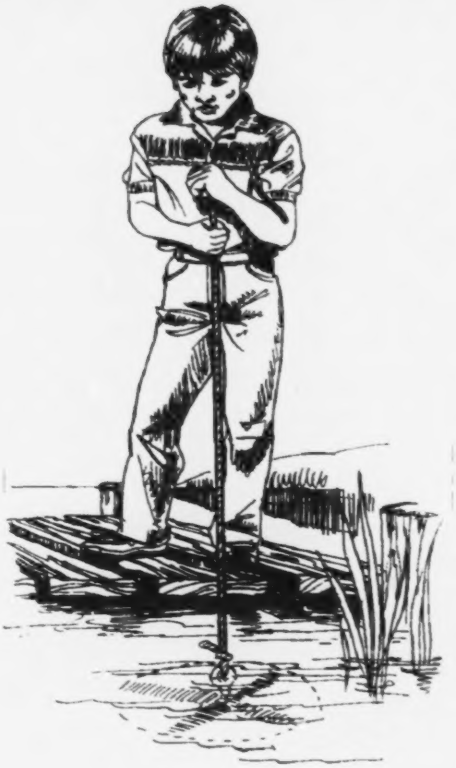
SECCHI DISK

Have students make a paper model of a secchi disk, according to the description in the background. If available, laminate these disks to use in experiments. Or, have students construct a secchi disk as a group from wood, old records or paint can lids. (Use heavy, solid wood, some will float even if weighted.)

To make a secchi disk from a paint can lid:

- Paint the can lid white, then paint a large black X on top.
- Punch or drill a small hole in the middle of the X and attach a string to the lid using an eye bolt and nut , or tie it and use weights.
- Mark off 0.1 meter increments on the string with a waterproof marker.

At a pond or lake: gently lower the disk into water until you can no longer see the X. Inch the disc back up until you can just barely see the X; hold the disc there. Reach down and grasp the string height at the surface of the water, and hold the string there while you pull the disk back out. By reading the markings on the string, determine the depth to which the light could penetrate. Compare readings from several places in the water. It is recommended that secchi disk readings be made between 9 am and 3 pm from the shady side of a dock, boat, etc.



Were there places that were more turbid than others? Were you able to see what caused the turbidity? Hint: Look for places where runoff and sediment are washing into the water from land. Are there fish or people stirring up the water?

2. Have students find a stream, pond or lake where high turbidity has been observed and determine the cause. Caution students not to go near water without supervision.

3. Have students write a paper from the perspective of a fish in muddy water and in clear water. They should address such questions as what they would eat in each environment, how reproduction, feeding, and migration will be affected, and their preferred habitat.

Runaway Water

Preparation Time: Easy-To-Do Moderate **Extensive**

Grade: 6 - 8

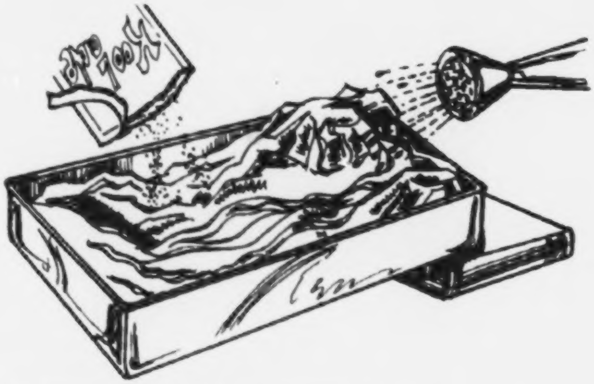
Focus: Understanding South Carolina's watersheds and how runoff can affect water quality.

Subject: Science, Geography

Materials: See itemized list below

Teaching Time: Several class periods

Vocabulary: Watersheds, runoff, storm drains, pollution, groundwater, nonpoint source pollution



Learning Objectives

In this activity, students will:

- see how South Carolina's watersheds direct the flow of runoff water
- see how man-made building, construction, and land clearing affect the path of water and water quality
- identify sources of pollution close to home and ways to prevent it.

Materials

This lesson includes an activity to make a simple watershed model and a review of South Carolina water basins. A map is included with this lesson. Extension activities suggest use of infrared maps and other maps available through the South Carolina Maps program that can offer an aerial view of your local area. If you plan to use these maps and your school does not have them, please allow time to obtain the maps.

Materials for making a watershed:

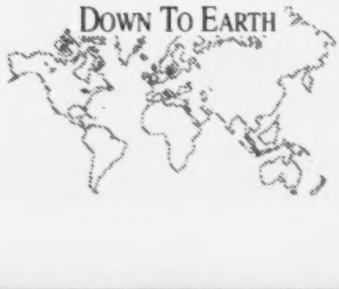
- shallow baking pans
- small cups or block
- aluminum foil
- dark colored powered drink mix (red works well)
- watering can
- water

Materials for reviewing South Carolina watersheds:

- a large S.C. map showing bodies of water
- water basins map included with this lesson
- maps from SC Maps Program of local area. You may use aerial maps of the school and adjacent areas or a wider view of your area.

Background

Exactly where water travels and how quickly it moves depend on various factors, such as an area's topography and vegetation, and its soil and rock types. Precipitation falls into water or on land, where it "runs off" of a hard surface such as rock or concrete or infiltrates a soft surface such as soil or sand. If water moves downward, it can replenish water contained in the underground rock and



In Haiti, although groundwater is plentiful, safe drinking water is scarce. Sewage systems and sewage treatment are nonexistent. Waterborne diseases are widespread.

source: *1994 Environmental Almanac*

sediment. This supply of water is referred to as "**groundwater**." Water remaining on the surface may flow through wetlands and enters local streams, rivers and lakes.

This land area from which water drains to any given point is referred to as a "**watershed**." For instance, a lake's watershed includes the streams entering it and the hills that drain into these streams and eventually into the lake. A large river, fed by many streams, is made up of many watersheds and is referred to as a "drainage basin." South Carolina has four major drainage basins, which themselves comprise many miles of rivers and streams, acres of lakes and square miles of wetlands and estuaries. (See map.)

Nonpoint source pollution, or NPS, is **runoff** water pollution that originates from many sources rather than one known point, such as an industrial discharge pipe or a tanker oil spill. This runoff **pollution** is any man-made or natural material carried by rainwater over land to enter **storm drains**, ditches, streams, rivers, estuaries, lakes, groundwater, and even the ocean itself, and thus becomes a part of the water cycle. This pollution may also come from man-made or natural materials dumped or emptied into the soil.

Examples of nonpoint source or runoff pollution include soil eroded from construction sites; fertilizers and pesticides from fields and lawns; metals and oil from automobiles; road salts; improperly discarded household hazardous waste; malfunctioning septic systems; animal waste from horses, cattle, waterfowl and pets; and excessive amounts of grass clippings, leaves and other natural debris. Man-made or natural materials, in small amounts, may not pose a threat to the environment. However, in amounts large enough to harm the organisms living in or using the water in a given area, these materials are pollution and degrade the quality of water. Excessive runoff pollution may also restrict many important uses of water such as drinking water, fishing, swimming, shell fish harvesting, etc.

The problems associated with nonpoint source pollution statewide appear to be proportional to the state's population density and distribution, and the intensity of agricultural activity and other land uses.

South Carolina's growing population of more than 3.6 million people is not equally distributed. Most people live near Columbia, Charleston, and the Greenville/Spartanburg area. In these active, urban regions, nonpoint source pollution amounts are prominent, though signs of it are found statewide. The growth of light industry, suburban expansion, and improved transportation corridors have exposed agricultural areas and vacant lands to development.

South Carolina's more rural counties, also suffer with various nonpoint source pollution symptoms, especially from farming activities.

Waterfront properties continue to attract both homeowners and businesses alike, developing or redeveloping properties along lakes, rivers, estuaries and oceanfront. Although these people do not pollute water deliberately, their actions and activities contribute to nonpoint source pollution.

The types and amounts of nonpoint source water pollution in any given area vary throughout the state. While rural areas have concerns with fertilizers, pesticides, sediments and animal waste; urban areas suffer more from trash and litter, chemicals and metals collected from paved areas by stormwater runoff; and coastal areas are damaged by construction and over-used or poorly maintained septic systems. The topography of the land, water velocity and depth, amount of rainfall and vegetation, weather conditions and the soil and rock types influence how quickly the pollutants mix with water and proceed to travel.

Nonpoint source water pollution has been identified as affecting water quality to some extent in all watersheds in the state. Under the federal Clean Water Act, state officials assessed South Carolina's nonpoint source water pollution and identified more than 336 waterbodies as pollution problem areas.

Learning Procedures

1. Discuss the background information with the class and help them define "watershed" and "nonpoint source water pollution." Use a large South Carolina map to pinpoint your county in the state, nearby waterways, and major waterways. Use the map included with this lesson to identify your drainage basin.

Discuss how water in your area is connected to a variety of land uses and human activities on land. Is your local area rural, suburban, or urban? What do local waterways flow through and how are they affected along the way?

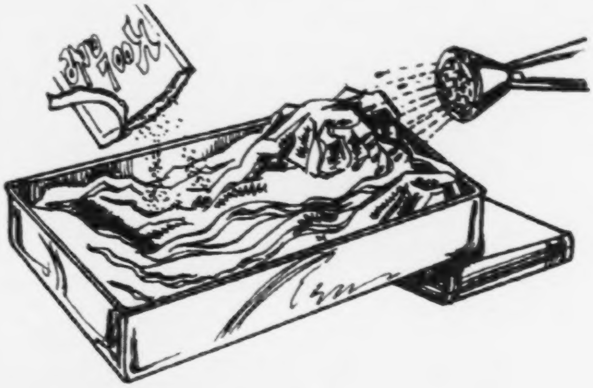
As a class have students participate in creating a map that characterizes your area and the things that may affect your waterways. What you find depends upon your area. Some things to look for are:

Rural
Horse farm/ horses
Agricultural farm/ crops
Irrigation ditches
Septic systems
A home
Schools

Suburban
Housing development
Condominiums
Apartment complex
Shopping mall/ parking lot
Schools
Construction site
Stormwater system
Roadways
Pets
Small marinas
Golf Courses
Gas stations

Urban
Many large buildings
Industrial sites
Wastewater facility
Construction site
Stormwater system
Many roadways
Pets
Large shipyard

2. In groups or as a demonstration, create the simple watershed model. (See illustration.)



Ask the class: What makes rainfall from the sky? *(gravity)* Does this also make water run downhill? *(yes)* Most waterways and wetlands lie downhill of the land around them. Rainwater runs downhill and eventually reaches these waterways.

Make a watershed: Place small cups or blocks in one end of a shallow baking pan; prop this end up on a book. Tear off a piece of aluminum foil longer than the size of the pan. Crinkle the foil. Cover the blocks or cups with the foil, and make a basin in the foil at the other end. This represents a watershed. The high end represents mountains or hills, the creases in the foil are streams and rivers that are bordered by wetlands, the basin is a large body of water (a lake or bay) that the rivers eventually flow into.

Pour "rain" gently over the watershed using cups or watering cans. Where does it all run? What would happen if the land had pollutants on it? Sprinkle some drink mix "pollutants" onto the watershed. Make it rain again and watch what happens.
What kinds of pollutants does the drink mix represent? It could be soil, fertilizer, chemicals, trash, gasoline or oil, etc. How do these pollutants get on the land and in

the water? Are you responsible for any of these actions?

What can you or other responsible people do to help prevent this pollution?

3. Use the "Getting to the Source" student worksheet included with this lesson to review the sources of nonpoint source water pollution.

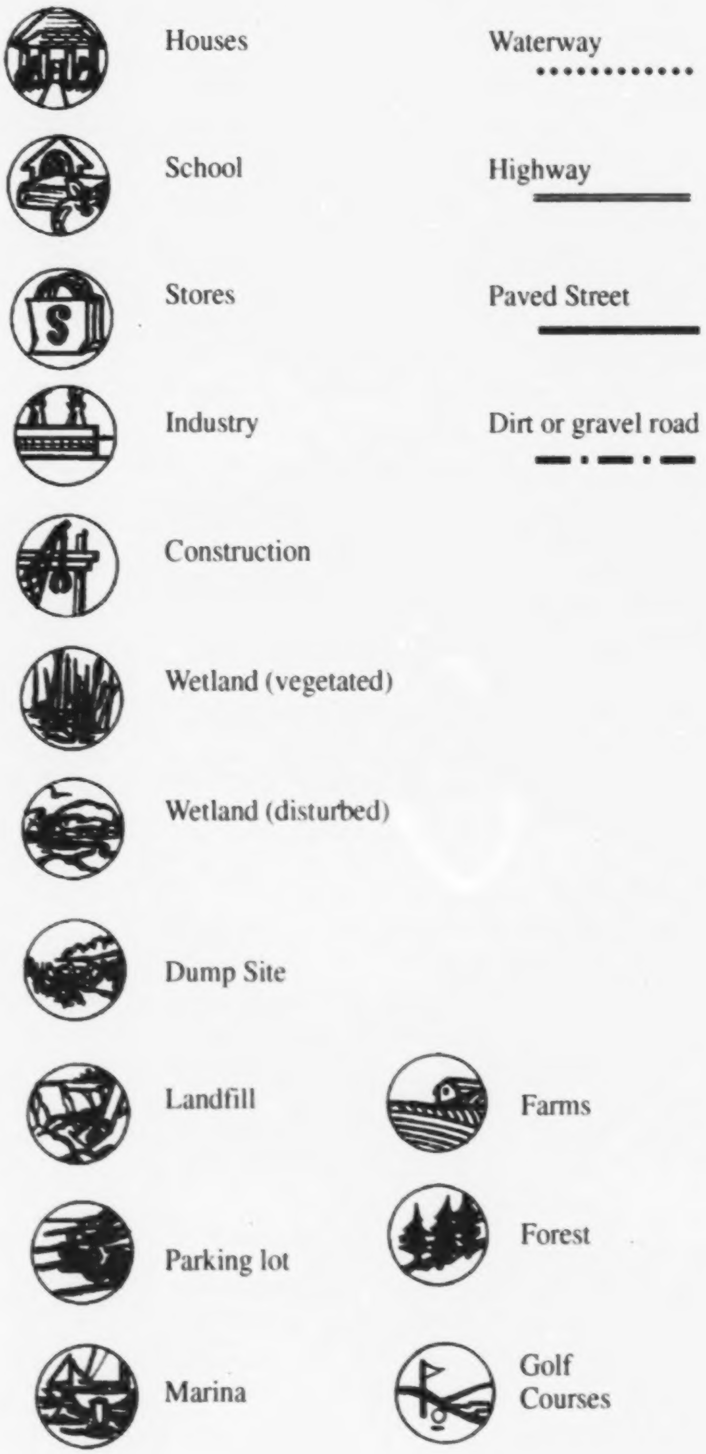
Extension Activities

1. Have students clip ads and newspaper and magazine articles from both local and national sources that can be directly or indirectly related to nonpoint source pollution.

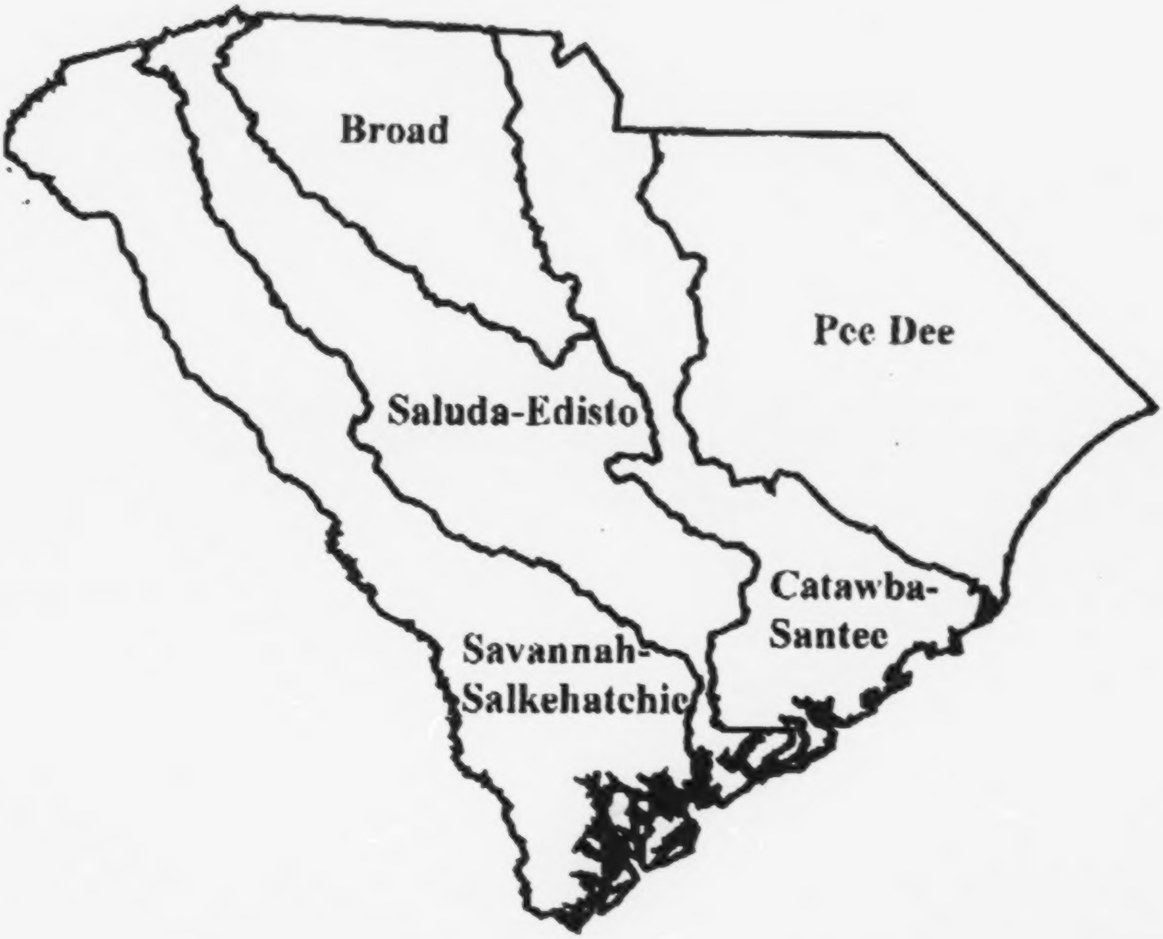
2. Use maps from the South Carolina Maps program to take an aerial look at your local area. Trace local waterways and consider the factors that might contribute to nonpoint source pollution as rainwater moves across the land and flows through waterways.

Have students create a map/drawing of their local area including buildings, roadways, and waterways. You may start at the school and the closest body of water. Students may use the sample map key symbols to mark on their maps for areas of interest.

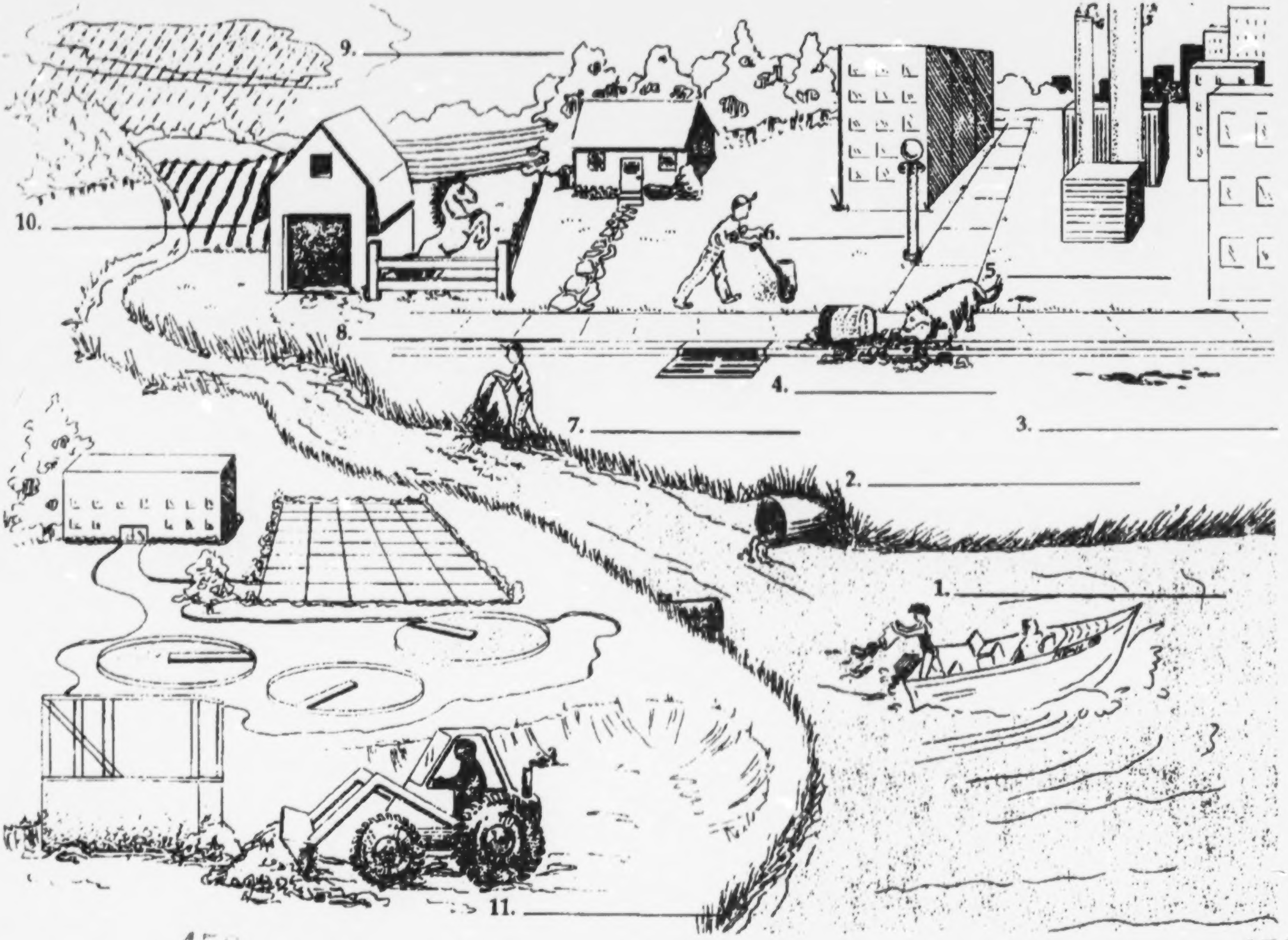
Sample Map Key


Houses
School
Stores
Industry
Construction
Wetland (vegetated)
Wetland (disturbed)
Dump Site
Landfill
Parking lot
Marina
Waterway
Highway
Paved Street
Dirt or gravel road
Farms
Forest
Golf Courses

South Carolina's Water Basins


Broad
Pee Dee
Saluda-Edisto
Catawba-Santee
Savannah-Salkehatchie

Getting to the Source



EXAMPLES OF RUNOFF POLLUTION

- Pesticides
- Pet Waste
- Trash and Raw Sewage
- Stormwater Runoff
- Acid Rain
- Fertilizers
- Grass Clippings
- Litter
- Erosion
- Dumped Oil

6 nps 3

The Water Table

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 6 - 8
Focus: Understanding the water table and how water moves through soil.
Subject: Science
Materials: See itemized list below
Teaching Time: One class period
Vocabulary: Water table, groundwater, percolation, impervious, pervious

Learning Objective

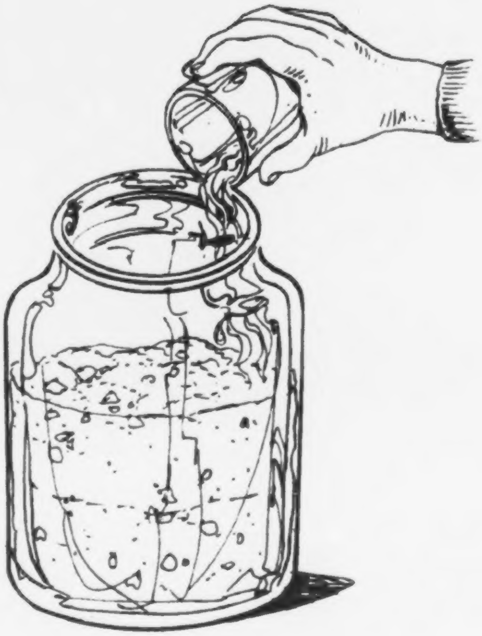
In this activity, students will create models of the water table and conduct an experiment to see how water moves at different rates through different types of soil. Students will discuss how the rate of flow through soil can affect the amount of pollutants that are filtered naturally by soil. Students will:

- see how water is stored in the ground
- see how water runoff and pollution move through soil.

Materials

See the illustration of the water table model on this page. You may present this as a demonstration or have students work in groups. For each group, materials include:

- wide-mouth glass jar (or a two-liter plastic soda bottle with the top cut off)
- a beaker, measuring cup, or any cup for pouring water
- crayon (dark color works best to mark on plastic) or permanent marker
- a mixture of sand and gravel (several cups)
- water (several cups)



Background

Precipitation falls into water or on land where it "runs off" of hard, or **impervious**, surfaces such as rock or concrete, or infiltrates soft, or **pervious**, surfaces such as soil or sand. If water moves downward, it can replenish water contained in the underground rock and sediment. This supply of water is referred to as "**groundwater**."

Groundwater is water that has percolated into the ground and is held under the surface. Rain seeps through the top layers easily. The earth near the surface is loaded with tiny air spaces. Even rocks have cracks and pores through which water can find its way. But when water reaches clay or impervious rock, it will not sink any farther.

DOWN TO EARTH

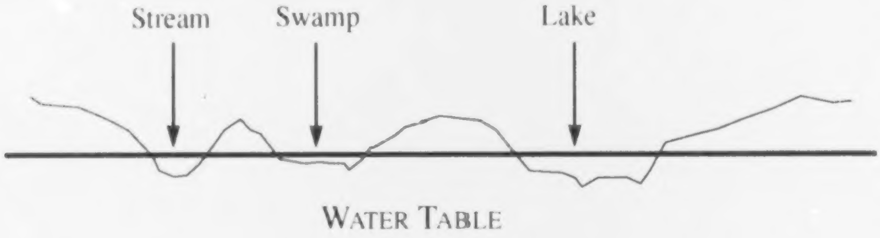
Japan uses 49.5% of its water for agriculture, 33.4% for industry, and 17% for homes. The United States uses 42% for agriculture, 46% for industry, and 12% for homes.
source: *1994 Environmental Almanac*

As more water seeps or **percolates** into the ground, it begins to collect above the bedrock or dense soil. When the ground has as much water as it can hold, it is said to be saturated. Water that seeps into the ground fills the tiny crevices and the water level rises toward the surface as the spaces in the ground fill up. The uppermost level is called the **water table**. The area of dry ground above the water table is called the zone or aeration. After heavy rains, the table is nearer the surface, and in dry weather it drops again.

Learning Procedure

1. Fill a clear container (soda bottle or jar) three-fourths full of sand and gravel mix. Next, pour water down the side of the jar until the water level rises about half way up the side of the jar. This water level should represent the level of the water table. Use a crayon or marker to mark the present level. Show the students that if they add more water, the water table will rise.

2. Have students use their crayon or marker and press down on the sand in one spot down to the water table to show that wherever the land surface dips below the water table, groundwater flows out to the surface. This forms springs, swamps, or lakes. Explain to the class that during dry weather periods the water table level goes down and some streams and swamps may dry up as well. You may want to draw the water table illustration below on the board as an example.



Just Do It

What can you **do to protect** groundwater? Never pour **any** household chemical on the ground. Remember **that** chemicals travel **easily** from the **ground** to our water.

Extension Activity
1. Have students perform the following activity to see how water moves through different types of soil.

How Different Soils Affect the Movement of Water
Students will measure volume accurately, identify by texture three types of soil, and make visual observations about the water movement through the soil.

Materials
You will need a set of materials for each student or student group.

- 3 large polystyrene cups
- 3 plastic coffee can lids
- 3 squares cheesecloth
- rubber bands
- water
- thumbtack
- watch or clock
- sand
- clay
- gravel
- pencil
- 4 - 250-ml beakers or cut off soda bottles
- scissors
- measuring cup

This activity should be preceded by a discussion of types of soils, and how water is absorbed into the soil and moves, with time, around the soil particles.

Demonstration procedure:
1. Using a thumbtack, punch several holes in the bottom and around the lower part of each cup. Make sure students punch the same number of holes in each cup.

2. Place a square of cheesecloth over the bottom of each cup so it covers all the holes. Secure the cheesecloth with a rubber band.

3. Using scissors, cut a hole in the plastic coffee can lid so that the cup just fits inside. Place each cup in a lid, and place each lid over a beaker. (See the illustration for the demonstration set up.)

Label the cups A, B, and C.

4. Fill Cup A half full of dry sand, Cup B half full of clay, and Cup C half full of a mixture of sand, gravel, and clay.

5. Have students make a chart similar to the one below for recording their observations.

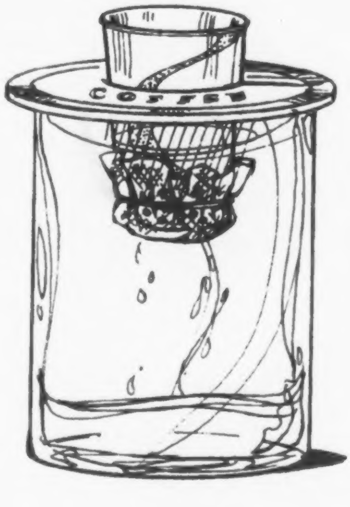
Cup	Time Water In	Time Water Out	Observations
A			
B			
C			

6. Pour 100 ml of water into the middle or center of each cup. Record the time when the water was first poured into each cup.

7. Record the time when the water first drips from each cup. Note the appearance of the water.

8. Allow the water to drip for 25 minutes. At the end of this time, remove the cups from the beakers. Measure and record the amount of water in each beaker.

Questions for the Class
Which soil sample is the most permeable? Which soil is the least permeable? How does the addition of gravel affect the permeability of clay? How does soil type affect the movement of groundwater? Can soil protect groundwater? Which one? How?



Action for a cleaner tomorrow.

A South Carolina Environmental Curriculum

For more information about South Carolina and the environment, call the
South Carolina Department of Health and Environmental Control at
1-800-768-7348.

Water Filters

Preparation Time: Easy-To-Do Moderate **Extensive**

Grade: 6 – 8

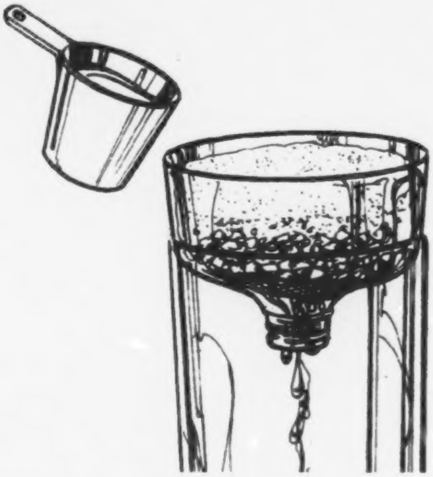
Focus: Using filters to clean water

Subjects: Science, Health

Materials: Two 12 ounce plastic soft drink bottles per filter, paper coffee filters (two for each bottle), clean washed sand, assorted small rocks, poly fiber stuffing (pillow stuffing), paper towels, several milk jugs filled with muddy water

Teaching Time: One class period

Vocabulary: Source water, groundwater, surface water, filter



Learning Objective

Students will:

- discuss ways to clean water
- hypothesize which filter will do the best job
- observe experimental results
- form conclusions based on experimental results
- use experimental results to decide on additional experimentation.

Background

Read the Resource section on Drinking Water.

Fresh water can be found in three main places on earth: as a **surface water**, as a **groundwater**, or frozen as snow and ice. All of these **source waters** can be used for drinking water. Stop and think for a minute if you would be willing to drink water as it is found in a lake or stream.

Before the water comes out of the faucet in your home, it needs to be made safe to drink. Public drinking water must meet the standards set by federal and state governments. The cleaning of water is done at a water treatment plant. The water treatment plant uses two basic techniques to clean and purify water for drinking. One method is to **filter** the water to remove dirt and other particles. The ancient Greeks wrote about pouring water through cloth to purify it. Some organisms that can cause waterborne illness are so small that they can pass right through filters. Water treatment plants can also clean water by treating it with a disinfectant to kill harmful germs.

Learning Procedure

1. Discuss the Background material about drinking water and where source water comes from in your area, i.e. is it groundwater or surface water? Ask the students if they would drink water right out of a lake or stream. Why not?

2. Discuss the purpose of a Water Treatment Plant. Review the two jobs of a Water Treatment Plant:

DOWN TO EARTH

Home water treatment devices are usually installed for two reasons: to purify contaminated water and to correct aesthetic problems such as taste, odor, color, or hardness.

Source: The Information Please Environmental Almanac, 1994

1) cleaning the water with filters, 2) disinfecting and preparing the water with chemicals.

3. Tell students that they are going to test several water filters. Prepare the water filters by cutting the bottom off of a 12 ounce soft drink bottle to form a funnel shape. (See the illustration.) Cut the neck and shoulders off of another soft drink bottle to form a cylinder with a bottom. Place the funnel (neck down) into the cylinder to form one complete filter. DO NOT ALLOW STUDENTS TO CUT OUT THE BOTTLES! This should be done by the teacher.

4. Prepare a set of four different filter setups for each team:

FILTER 1: Place enough poly fiber in the funnel to fill it to within one inch of the top. Pack the poly fiber down well.

FILTER 2: Place two coffee filters in the funnel. Place them so as to prevent any water poured into the filter from passing between the coffee filter and the wall of the funnel.

FILTER 3: Place small rocks into the funnel. Fill to within one inch of the top.

FILTER 4: Place a folded paper towel inside the neck of the funnel to prevent escape of sand. Fill the funnel with clean sand to within one inch of the top.

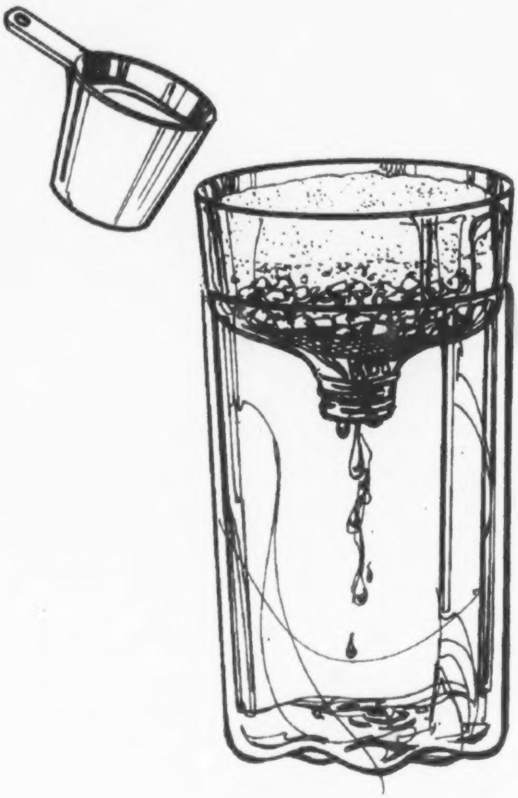
5. Line up the four types of filters on the demonstration desk. Ask the students to hypothesize which filter they think will work best. Why?

6. Pass around milk jugs of muddy water. Have each team pour some muddy water through each type of filter and observe what happens. Record your observations.

7. Have students report their results to the class and compare results. Which type of filter worked best? Why? What types of filters do Water Treatment Plants use?

Extension Activity

Have the students design their own filters using the soft drink bottle setup. How would the teams design the best filters for cleaning water? What about using a combination of materials? Reiterate to the students that even though the filtered water *looks* clean, it is still not fit to drink and must be chemically treated to kill germs.



Just Do It

Help keep your local water supply clean. Never pour oil, or any chemicals, out on the ground where they can wash into our water.

Take Me To Your Meter

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 6 – 8
Focus: Water conservation
Subjects: Science, Math
Materials: Meter reading worksheet (included)
Teaching Time: One class period
Vocabulary: Water treatment plant, distribution system, water meter, water conservation

Learning Objective

Students will:

- determine if they have a water meter and locate the meter
- determine the type of water meter at their home
- learn to read a water meter
- learn to use a water meter to measure water use
- examine a water bill and learn to calculate the cost of water.

Background

After the water leaves the **water treatment plant**, it travels along pipes in the **distribution system** to get to your home. It must pass through a **water meter** to measure the amount of water used in your home in order for a water bill to be calculated. Usually the water meter is located outside of the home at some point between the pipes running under the street and the pipe carrying water into the home.

If you have a well or a spring, you will not usually have a water meter. The water is yours to use without paying anyone. You may also not have your own water meter if you live in an apartment building or a trailer park. All the water used is divided up among the users and each is charged an equal share. If you do not have a water meter, you will have to be more conscientious about water use in your home without being able to measure.

There are several kinds of water meters. Some meters are a single dial meter with all of the numbers displayed in boxes for tens, hundreds, thousand, etc. On this type of meter, only the one unit is displayed on the dial. Sometimes all of the numbers are displayed on the face and no dial is on the meter. Older style meters have a dial for every unit component of a number, i.e. a dial for ones, a dial for tens, a dial for hundreds, etc. These six dial meters are a bit more difficult to read. To read this style of water meter, locate the dial which reads the largest (usually 100,000) number, then proceed around the dial reading the small dials in a clockwise direction. At each dial, look and see what number the needle is pointing to. If the needle is between two numbers, chose the smaller number (except when between 9 and 0). It is important to learn to read your water meter in order to practice **water conservation**.

Learning Procedure

To do this lab, the student will need to find out: 1) if they have a water meter at home, 2) where the water meter is located, 3) what type of dial system they have on their water meter, 4) how to read their own water meter, and 5) how to use their water meter to measure water usage and conserve water.

CAUTION: The metal box that holds the meter has a heavy lid that can fall down on a student's hand. The area inside the box is a perfect habitat for all

DOWN TO EARTH

In the past century, every major U.S. river has been harnessed for irrigation, hydro electric power, flood control or a combination of these purposes.

Source: The Information Please Environmental Almanac, 1994

kinds of creatures, so the students should be prepared to see toads, roaches, etc. Along with these other insects, this dark habitat is a perfect spider location and may contain a dangerous spider such as the brown recluse spider. Therefore, parents should be involved in the location and reading of the meter and appropriate cautions should be pointed out before beginning.

Part I

As homework, have each student find the answers to the first three questions above. Bring these answers to class on the day that the class learns to read the different types of water meters.

Part II

1. Using the enclosed worksheet, look at the first example of a water meter. Notice that it is a six-dial style of meter. Each dial represents a unit of a six digit number (100,000). Locate the dial representing the hundred thousand digit. **Ask:** what number does the needle point to? (*The standard rule is that if the needle is between numbers, always choose the smaller number* ***except*** *when the dial is between 9 and 0. In this case, the smaller number is going to be the 9.*)

2. Locate the dial for the ten thousand digit. Read it. Locate the dial for the one thousand digit. Read it. Continue until all of the dials have been read. What is the total number for the meter. Does this meter read in gallons of water used or cubic feet of water used?

3. Look at the example of a single dial meter. This is more common in newer neighborhoods. On this meter, all of the numbers are already listed, except for the ones. The dial is currently registering this number. As above, if the needle is between numbers, choose the smaller number except in the case of a needle between 9 and 0. Record the number from this meter.

4. Practice reading different styles of water meters with the attached work sheet.

Part III

Once you have developed a proficiency with water meter reading, it is time to put this to good use to discover how your family uses water. With *Adult Supervision*, perform the following homework assignments:

A. Turn off all of the faucets both inside and outside of your home. Read your water meter. Go inside and flush one toilet. Go back outside and read your water meter. How much water was used?

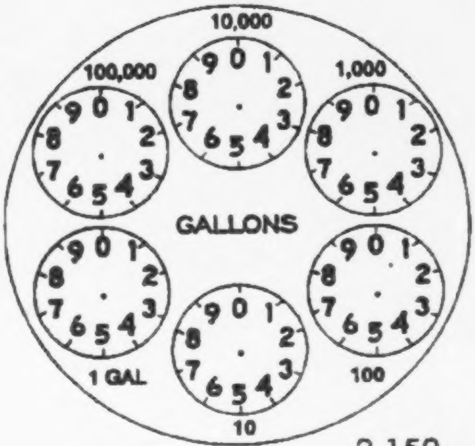
B. Repeat this assignment in the morning. Choose either brushing your teeth or taking a shower for your measurement. Make sure no other water is used during this time so that you can get an accurate measurement.

C. Turn off all of the water faucets both inside and outside your home. If you have an automatic ice maker on your icebox, have an adult help you to turn it off also. Try to make sure no one needs to use any water for a while, including using the bathroom. Take a meter reading. Wait one half hour and take another reading. Did you meter record any water usage? Check again to make sure no one used any water. If your meter indicates some water was used, you may have a dripping faucet or a leaking toilet somewhere in your house. Estimate how much water is lost in 24 hours. See if you can find a leak.

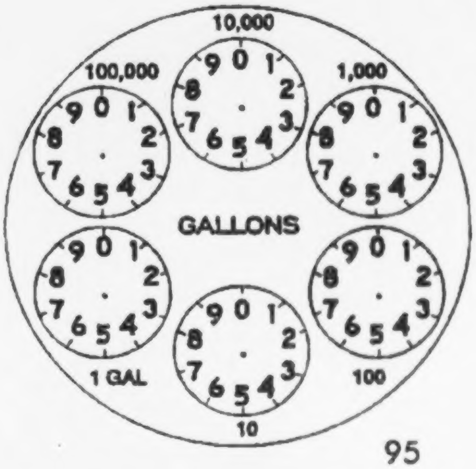
D. Obtain a copy of your water bill. What is the total cost for the current month? How much water was used? What other charges are added to your water bill? If your sewer bill is part of your water bill, what percentage is charged? As a class, find out if your water supplier averages your monthly water use over a one-year period.

Extension Activity

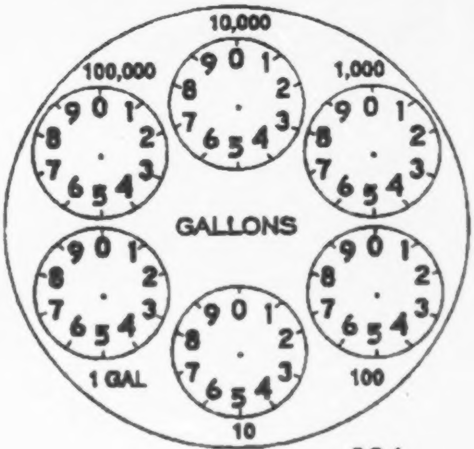
Find out if your toilet is leaking by putting a few drops of bright colored food coloring into the tank behind the seat. Do not flush the toilet for at least 20 minutes. After the 20 minutes, check to see if any of the color has "leaked" into the bowl of the toilet. If it has, you have a leak to stop. Sometimes you can hear water running when near a toilet. This also indicates a leak.


10,000
100,000
1,000
GALLONS
1 GAL
100
10

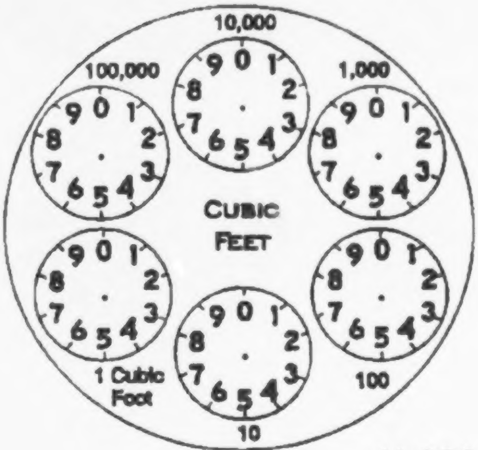
2,159


10,000
100,000
1,000
GALLONS
1 GAL
100
10

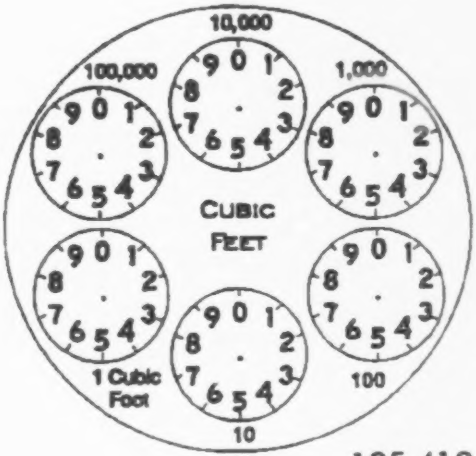
95


10,000
100,000
1,000
GALLONS
1 GAL
100
10

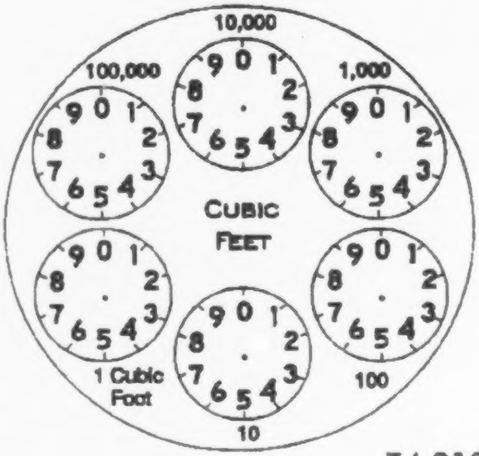
836


10,000
100,000
1,000
CUBIC FEET
1 Cubic Foot
100
10

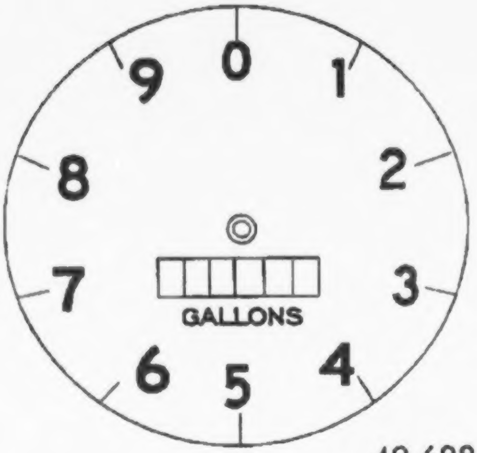
61,520


10,000
100,000
1,000
CUBIC FEET
1 Cubic Foot
100
10

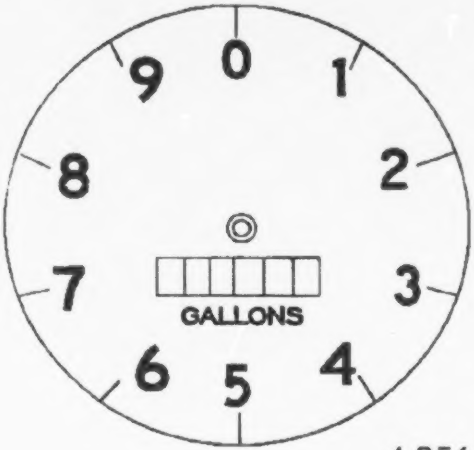
195,412


10,000
100,000
1,000
CUBIC FEET
1 Cubic Foot
100
10

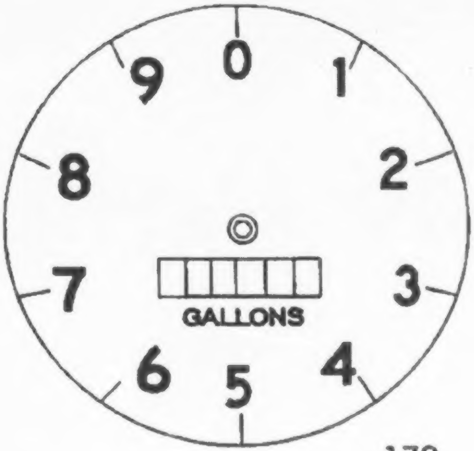
74,313


9
0
1
8
2
7
3
6
5
4
GALLONS

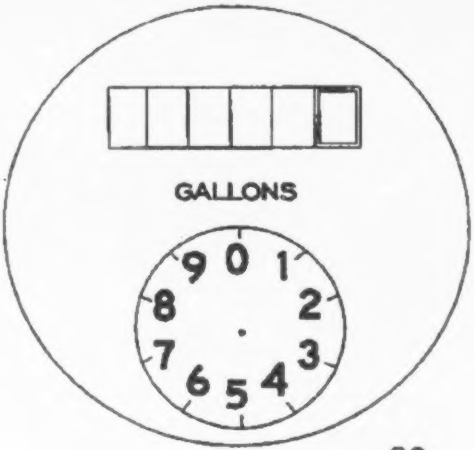
49,688


9
0
1
8
2
7
3
6
5
4
GALLONS

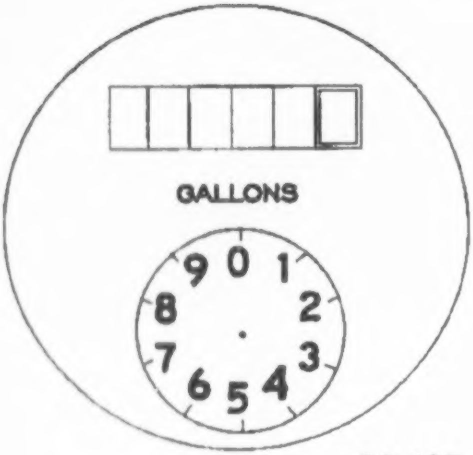
4,356


9
0
1
8
2
7
3
6
5
4
GALLONS

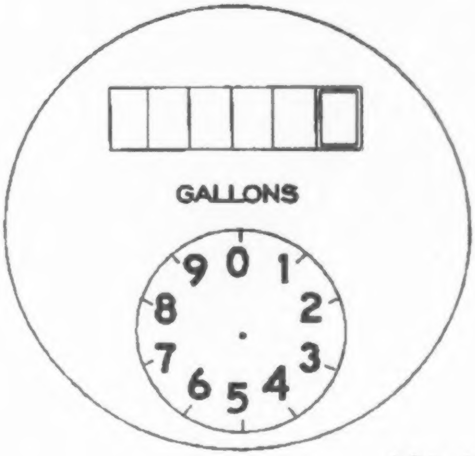
179


GALLONS
9
0
1
8
2
7
3
6
5
4

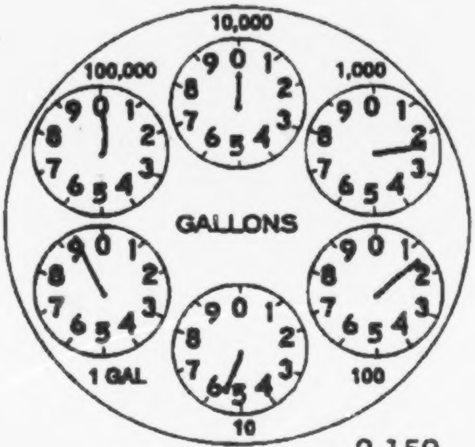
20


GALLONS
9
0
1
8
2
7
3
6
5
4

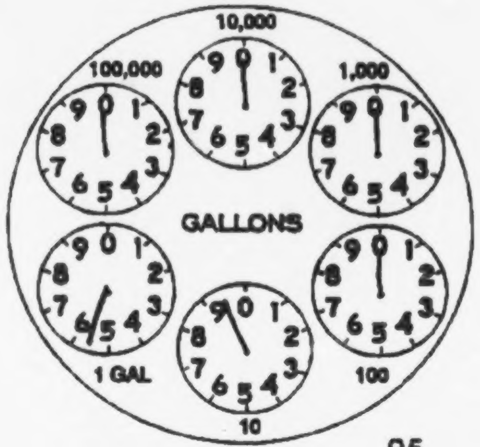
53,427


GALLONS
9
0
1
8
2
7
3
6
5
4

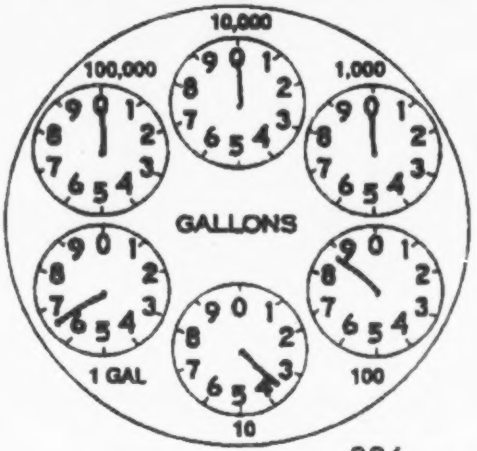
101,475


10,000
100,000
1,000
GALLONS
1 GAL
100
10

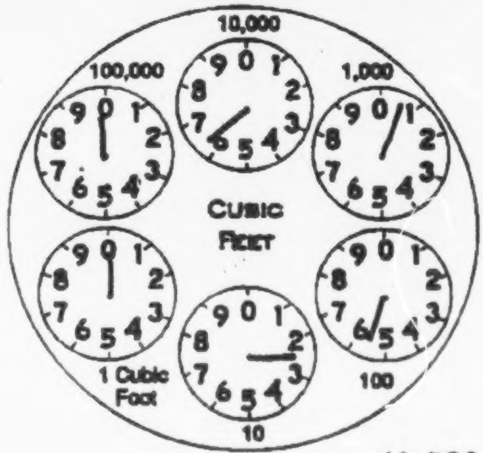
2,159


10,000
100,000
1,000
GALLONS
1 GAL
100
10

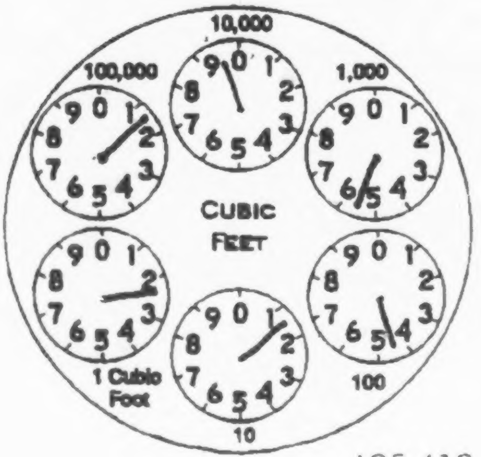
95


10,000
100,000
1,000
GALLONS
1 GAL
100
10

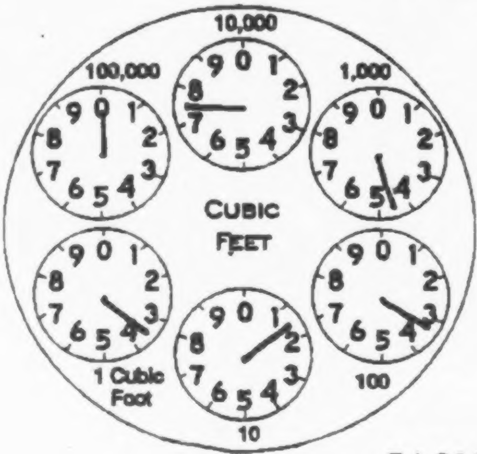
836


10,000
100,000
1,000
CUBIC
FEET
1 Cubic
Foot
100
10

61,520

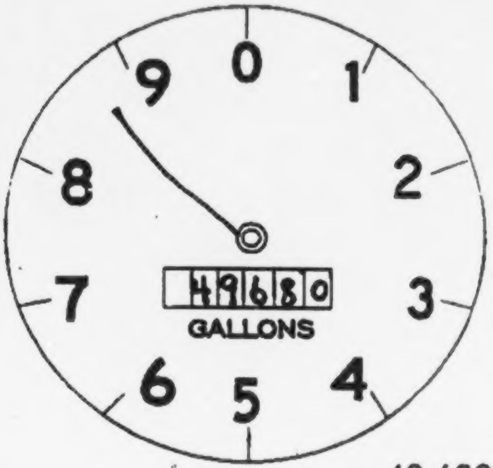

10,000
100,000
1,000
CUBIC
FEET
1 Cubic
Foot
100
10

195,412

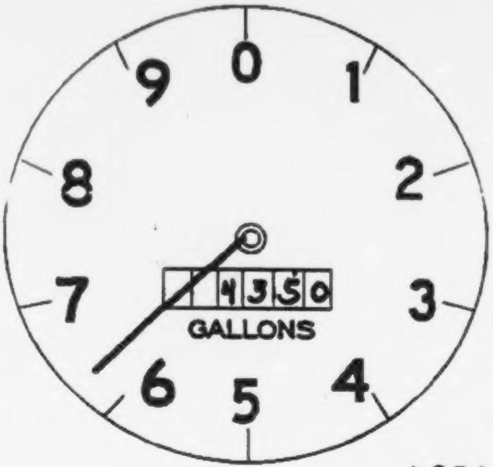

10,000
100,000
1,000
CUBIC
FEET
1 Cubic
Foot
100
10

74,313

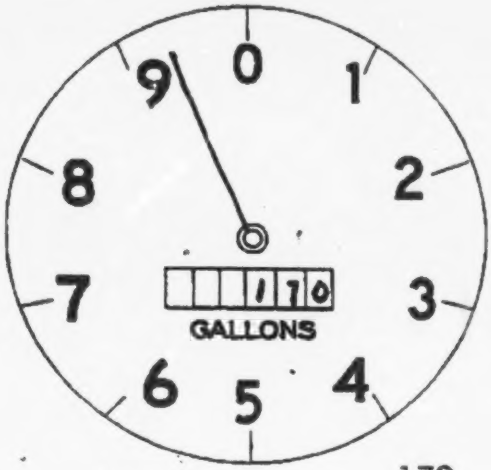
TEACHER ANSWER SHEET


9 0 1 2 3 4 5 6 7 8
49680
GALLONS

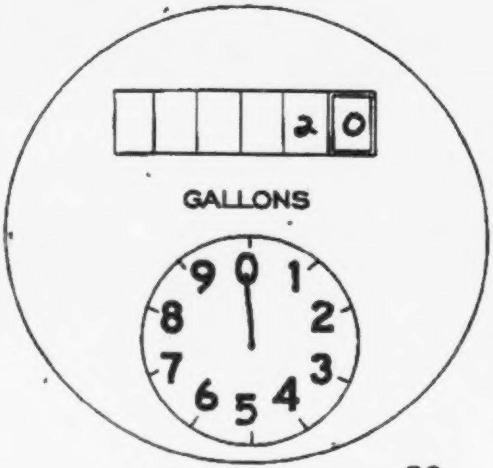
49,688


9 0 1 2 3 4 5 6 7 8
4350
GALLONS

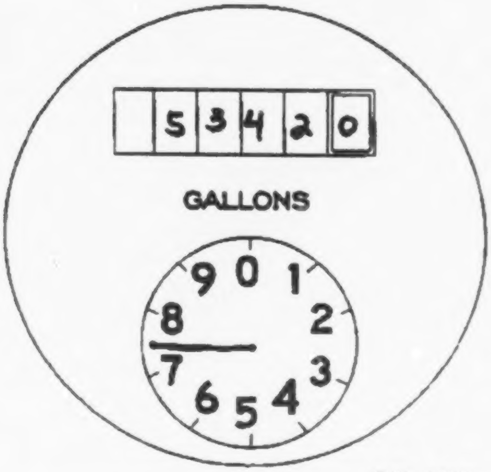
4,356


9 0 1 2 3 4 5 6 7 8
170
GALLONS

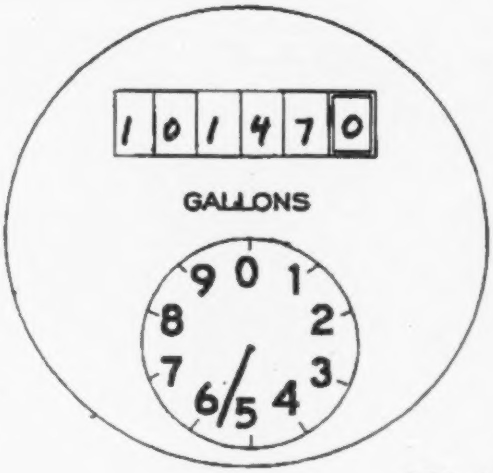
179


20
GALLONS
9 0 1 2 3 4 5 6 7 8

20


53420
GALLONS
9 0 1 2 3 4 5 6 7 8

53,427


101470
GALLONS
9 0 1 2 3 4 5 6 7 8

101,475

Salt Water & Sinkholes

Preparation Time: Easy-To-Do Moderate **Extensive**

Grade: 6 - 8
Focus: Water conservation
Subjects: Science, Geology, Hydrology
Materials: Two clean plastic two liter soft drink bottles per team, clear plastic soda straws, duct tape, aquarium gravel, red food coloring, soap bottle pump, cardboard box from a case of soft drinks, aluminum foil, dirt, balloon, funnel, water, bucket, plastic or paper houses
Teaching Time: One class period
Vocabulary: Groundwater, recharge, aquifer, salt water intrusion, sinkhole

Learning Objective

Students will:

- observe what happens when water is drawn out of an aquifer
- build a model and observe an example of salt water intrusion
- build a model and observe how a sinkhole is formed
- examine a real life water management problem.

Background

In South Carolina 60 percent of the population gets their drinking water from **groundwater**. Rain and other precipitation falls on the surface and either runs off into surface water bodies or soaks down to become part of this underground store of water. We use the term **recharge** to describe the replenishing of groundwater by precipitation soaking down. Areas that contain supplies of groundwater are called **aquifers**. Without a way to replenish water to the groundwater stores, it might be possible to withdraw all the water stored in an aquifer. As stewards of the Earth's fresh water stores, we must be careful not to draw more water out than can be naturally replenished through recharge.

If water is drawn out of the aquifer faster than it can be replenished, the water table in the aquifer can drop below sea level. In areas along the coast, salt water will seep in to fill the spaces which once held fresh water. This is called **salt water intrusion**. Salt water intrusion causes the water drawn up from wells to become slightly salty or brackish and unfit for drinking. Hilton Head Island, South Carolina is currently dealing with salt water intrusion problems and there are no easy solutions. The best management practice is to maintain a level of water withdrawal which keeps up with the recharge.

In South Carolina, most of the geologic layers under the ground are solid rock or mixtures of different types of soil such as sand and clay. In some parts of the United States, such as Florida, the underlying rock is limestone. If the groundwater is slightly acidic, it can dissolve the limestone forming caverns under the ground. As long as these caverns are filled with water, the surface is supported. But if all the water is pumped out of a limestone aquifer, it is possible for the surface to collapse downward to form a **sinkhole**.

Learning Procedure

1. Divide the students into teams of four and give each team two clear plastic two-liter soft drink bottles labeled "A" and "B," a straw, and some duct tape. You should have already poked a small hole in each bottle about halfway down the bottle. The

Down To Earth

The Rio Grande and one of its tributaries, the Rio Conchos, are at the top of North America's list of most endangered and threatened rivers.

Source: The Information Please Environmental Almanac, 1994

students should insert each end of the straw into a bottle so that the two bottles are connected by a straw. Seal off the point where the straw and bottle join with duct tape so that no water leaks from the straw holes.

2. Fill bottle "A" with aquarium gravel to a level above the straw hole. (This can be done the day before as preparation for the experiment.) Fill each bottle with water to just above the gravel level. Bottle "B" will contain only water and represents an aquifer.

3. Insert the soap dispenser pump in gravel bottle "A" and pump the water out into the bucket. Note how the water moves from bottle "B" through the straw to replenish the water that is drawn out of bottle "A" by the pump. As long as water is added to bottle "B," we can continue to draw as much as we want from bottle "A." This is much the same as might happen if water were drawn out of an aquifer at the same rate as recharge was added.

If no water is added to bottle "B," continued pumping will remove all of the water out of bottle "A" and the water level in bottle "B" will drop below the straw so that bottle "A" no longer has access to the water in "B."

4. Refill both bottles up to a level above the gravel. Make the water in bottle "B" represent salt water by adding a few drops of red food coloring so that we can see what happens to this water. Pump bottle "A" to withdraw water. What happens? As fresh water is drawn out of bottle "A," salt water (red) moves across the straw and replaces the fresh water and the well now pumps water that is too salty to drink. This is salt water intrusion.

5. Create a sinkhole by setting up the following model:

A. Open one end of a cardboard box used to hold a case of soft drinks by cutting both edges of one side down to the bottom of the box and folding the resulting flap down. Line the box with foil to make it water resistant.

B. Fill the box with loose dirt. Fill a balloon with water and close the end with a rubber band. This represents an aquifer.

C. Bury the balloon in the middle of the box close to the surface, but allow the sealed end to stick out of the dirt on the end which has been opened. Place some model houses on top of the dirt to simulate a village.

D. Place the bucket under the open end of the box. Open the balloon and gradually drain the "aquifer" into the bucket. When all the water has been drained out of the balloon, what happens?

E. Discuss what would happen to a limestone aquifer that was totally emptied? What would happen to the houses on top of this aquifer? What are some ways to prevent both salt water intrusion and sinkholes?

Extension Activity

Have each team divide into two units, one unit representing farmers whose only source of income is their crops and one unit representing water managers who must make sure that all the groundwater is not used up. Imagine a three month drought has occurred. The farmers need more and more water out of their wells to sustain their crops. The water managers have to maintain the aquifer.

Have the teams list all the possible solutions to good water management so that the crops don't fail but also the aquifer is not emptied. Have each team choose a solution which agriculture and water managers can agree on. Report all of the team solutions to the class.

South Carolina's Bodies of Water

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 6 – 8
Focus: South Carolina's rivers, lakes, and reservoirs
Subjects: Geography, Social Studies, Language Arts, Science
Materials: Map of South Carolina rivers, lakes, and reservoirs (included), colored pencils, markers, crayons, a classroom wall map of South Carolina
Teaching Time: One class period
Vocabulary: Source water, watershed, runoff

Learning Objective

Students will:

- locate 11 South Carolina cities on a map
- locate their home county on a map
- locate 16 South Carolina rivers on a map
- locate 12 South Carolina lakes on a map
- locate two South Carolina reservoirs on a map.

Background

Water is one of South Carolina's most precious resources. We have miles of beautiful rivers and countless lakes for boating, fishing, and swimming. Not only are these waterways enjoyable because of their sheer beauty, but many of these water bodies also provide the **source water** for much of our state's public drinking water.

The best way to learn the names and locations of South Carolina water bodies is to visit each one. This might take years, so the next best way is to practice the names and locations with maps and map associated activities.

It is also important to know the location of these water bodies so that we may better understand about watersheds. A **watershed** is a region of land that drains all of its **runoff** into a specific river or other body of water. When the body of water receiving the runoff is also a water source for public drinking water, it becomes very important to protect that watershed so that it has the very best water quality.

Learning Procedure

Students may work singly or in teams of two. Use the unlabeled South Carolina map and some colored pencils or markers. Have a large scale South Carolina map for easy access. Have students label the following items on their map:

1. Color your home county yellow.

2. Find and label the following South Carolina cities as location references for the water bodies:

Aiken
Anderson
Beaufort
Camden
Charleston
Columbia
Florence
Greenville
Myrtle Beach
Spartanburg
Sumter

Down To Earth

In South Carolina, the per capita water consumption is 1,916 gallons. The average amount of water used per day is 6,820 million gallons.

Source: The Information Please Environmental Almanac, 1994

3. Label and color blue the following South Carolina rivers:

- Ashepoo
- Savannah
- Pee Dee
- Cooper
- Catawba
- Wateree
- Combahee
- Black
- Tyger
- Saluda
- Edisto
- Enoree
- Congaree
- Broad
- Waccamaw
- Santee

4. Label and color purple the following South Carolina lakes and reservoirs:

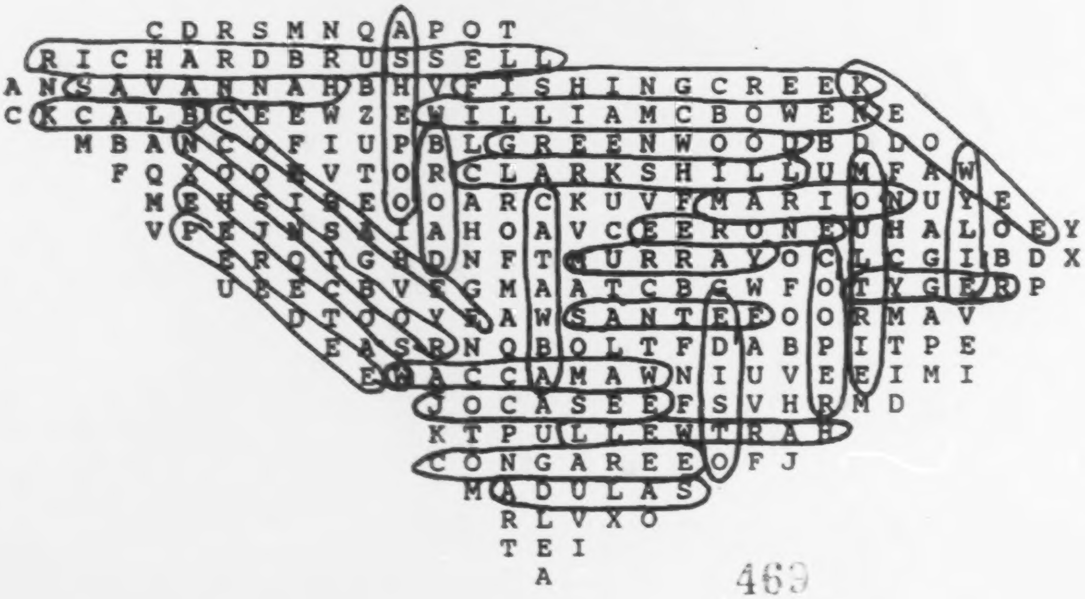
- Clark's Hill Reservoir
- Fishing Creek Reservoir
- Lake Greenwood
- Lake Hartwell
- Lake Jocasee
- Lake Keowee
- Lake Marion
- Lake Moultrie
- Lake Murray
- Richard B. Russell Lake
- Lake Robinson
- Lake Wateree
- Lake William C. Bowen
- Lake Wylie

5. Give a copy of the word search to each student and have them use the water bodies listed in Numbers 2 - 4 to complete the work sheet.

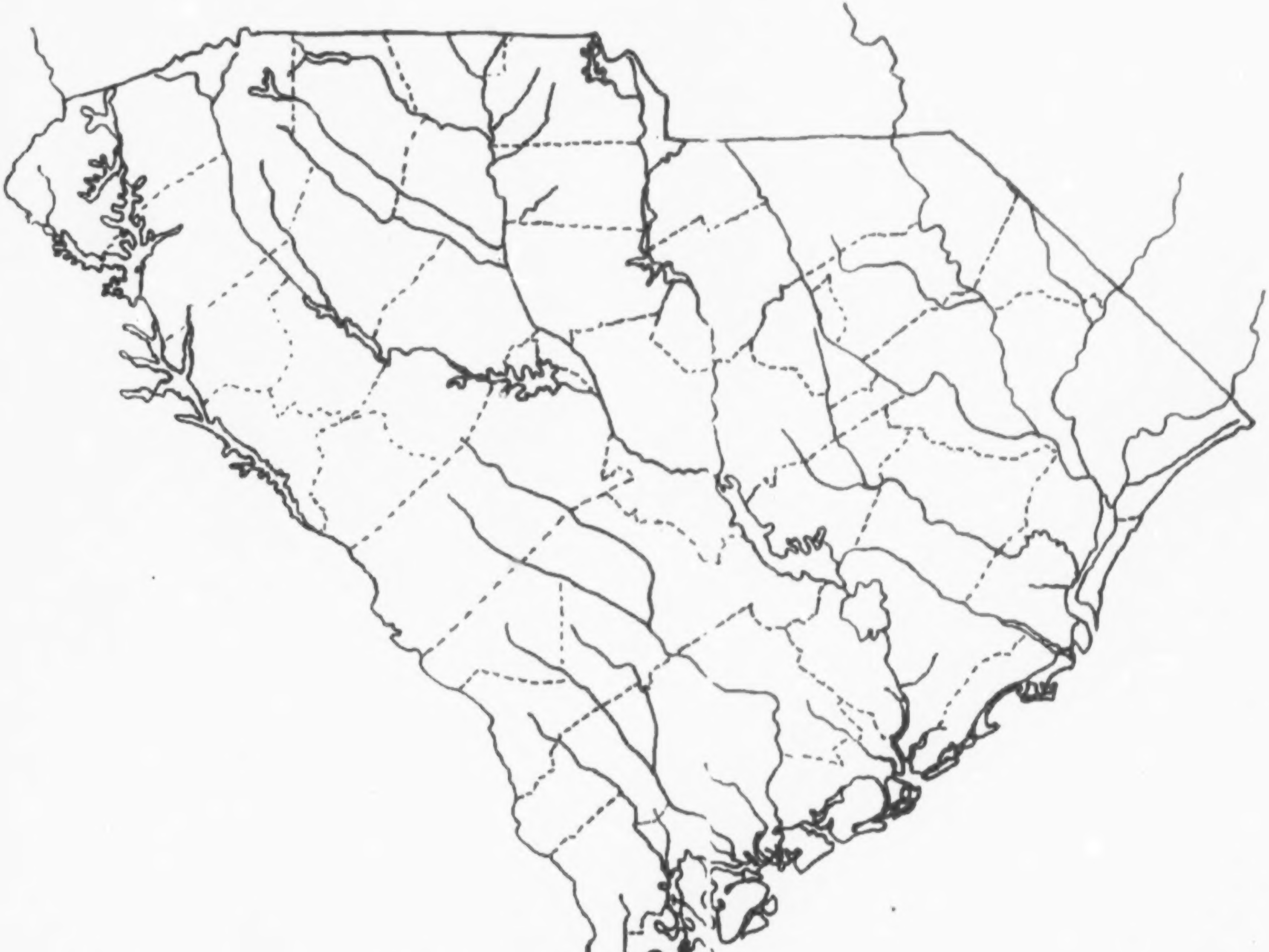
Just Do It

Be aware that anything you pour on the ground — oil, fertilizers, chemicals — can end up in your local stream, river, or lake!

WORD SEARCH KEY



C D R S M N Q A P O T
R I C H A R D B R U S S E L L
A N S A V A N N A H B H V F I S H I N G C R E E K
C K C A L B C E E W Z E W I L L I A M C B O W E N E
M B A N C O F I U P B L G R E E N W O O D B D L O
F Q X O O B V T O R C L A R K S H I L L U M F A W
M E H S I B E O O A R C K U V F M A R I O N U Y E
V P E J N S A I A H O A V C E E R O N E U H A L O E Y
E R Q I G H D N F T M U R R A Y O C L C G I B D X
U B E C B V E G M A A T C B G W F O T Y G E R P
D T O O Y E A W S A N T E E O O R M A V
E A S R N O B O L T F D A B P I T P E
E W A C C A M A W N I U V E E I M I
J O C A S E E F S V H R M D
K T P U L L E W T R A H
C O N G A R E E O F J
M A D U L A S
R L V X O
T E I
A



NAME: ______________________

South Carolina Water Bodies Word Search

```
        C D R S M N Q A P O T
  R I C H A R D B R U S S E L L
A N S A V A N N A H B H V F I S H I N G C R E E K
C K C A L B C E E W Z E W I L L I A M C B O W E N E
    M B A N C O F I U P B L G R E E N W O O D B D L O
      F Q X O O M V T O R C L A R K S H I L L U M F A W
        M E H S I B E O O A R C K U V F M A R I O N U Y E
        V P E J N S A I A H O A V C E E R O N E U H A L O E Y
            E R Q I G H D N F T M U R R A Y O C L C G I B D X
            U E E C B V E G M A A T C B G W F O T Y G E R P
                D T O O Y E A W S A N T E E O O R M A V
                  E A S R N Q B O L T F D A B P I T P E
                    E W A C C A M A W N I U V E E I M I
                        J O C A S E E F S V H R M D
                        K T P U L L E W T R A H
                        C O N G A R E E O F J
                          M A D U L A S
                            R L V X O
                            T E I
                              A
```

Can you find the names of 29 South Carolina rivers, lakes, and reservoirs?

The names can appear up and down, sideways, or on a slant. They can be spelled forwards or backwards. See how good a detective you can be …

Power in South Carolina

Preparation Time: Easy-To-Do **Moderate** Extensive

Grade: 4 - 5 & 6 - 8

Focus: The various forms of energy used to produce electricity in South Carolina.

Subject: Science, Social Studies

Materials: Handouts included with this lesson

Teaching Time: One class period, plus student work

Vocabulary: fossil fuels, nuclear reactor, nuclear fission

Electricity-Generating Plants in South Carolina

Learning Objectives

In this lesson students will interpret charts, graphs, and illustrations to discover the story of power in South Carolina. Students will:

- see how electricity is generated and distributed in South Carolina.

Materials

Handouts "Power in South Carolina"
Copies of "The Energy FactBook: A Resource for South Carolina" (Optional: These are available from the S.C. Department of Health and Environmental Control's Resource Center, 1 800 SO USE IT, or the State Energy Office, 1 800 851 8899.)

Background

excerpts from "The Energy FactBook: A Resource for South Carolina"

South Carolina is a growing state. As our economy has developed, so too have our energy needs. In the last several decades, only four states have had higher energy use rates than we in South Carolina have had.

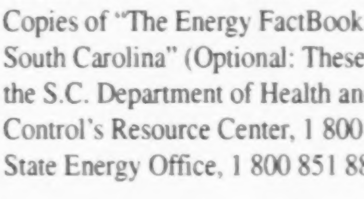
While we use energy in every sector of the economy, industry uses the most. It takes large supplies of energy to run the mills, factories, and farms that make our state prosper. In 1991, industry accounted for 40% of the state's energy use.

The transportation sector is the second largest user of energy, using 27 % of the state's total use. As primarily a rural state, South Carolina is state of drivers. It takes nearly 2 billion gallons of gasoline a year to keep South Carolina moving.

In our homes, we use 20% of the state's energy and the commercial sector uses the other 13%.

South Carolina does not have many natural energy resources of its own. The gasoline and other fossil fuels that make our economy grow must be imported from other states and countries.

Through science and conservation, we are now using proportionately less fossil fuels. In 1990, over one-third of the state's energy needs were met by energy resources other than fossil fuels.



The United States Environmental Protection Agency (EPA) estimates that computers account for 5 percent of commercial electricity use. New computer chips that "sleep" when not in use are expected to save 50 to 70 percent of this energy.
source: *1994 Environmental Almanac*

Learning Procedure

1. **Ask the class:** When we switch on a light, what is the source of this power? *(Students may say power lines or power plants in general or they may be familiar with a local plant.)*

Ask: How was this power created? (*Review with students the basics of electric power generation. You may use videos, such as Santee Cooper's* PowerHouse Tour *to review the generation process. The illustration,* Producing Electricity, *included with this lesson gives the basics.*)

Ask: What can we tell about the different types of fuel sources that are used to produce electricity? *(They each create heat that is used to create steam that turns the turbine that creates electricity.)*

2. Tell the class that there is a lot that you can learn about power in South Carolina from interpreting charts, graphs and illustrations, just the way they interpreted the basic illustration, *Producing Electricity*.

Give each student or small groups of students a copy of the handouts, *Power in South Carolina*, and have them read the text and interpret the graphics to answer the questions and learn more about power in our state.

Extension Activities

1. Have students research an energy source – coal, oil, natural gas, nuclear, solar power, wind, etc – used in creating energy. Students should be encouraged to find:
    - How was it formed (for fossil fuels) or the process that causes it (solar, etc.)
    - The availability in our state, country, world
    - Environmental advantage/disadvantages.

2. Have students consider a good way to reduce energy use in the state and then write several paragraphs to explain. For example, they may suggest the use of more public transportation to reduce energy used for transportation (petroleum), or ways to lower residential energy use through use of solar heating or other efficient usage practices, or ways factories could save energy.

3. Have students write letters to the utility company that supplies their electricity asking about how power will be supplied in the future.

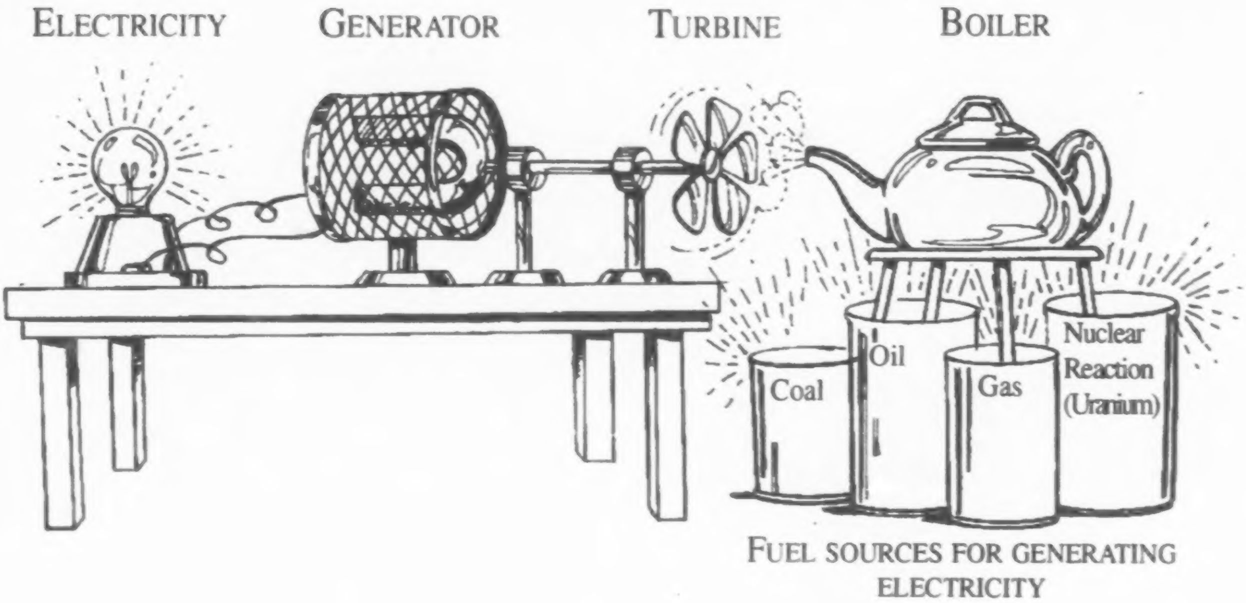
Does your power company have any investments in renewable energy or other alternative energy technology? Why or why not?

4. Plan a field trip to a power generating facility in your area or invite a representative to come to your school.

Just Do It

Use energy wisely at home. Conduct a home energy audit to determine if your home is energy efficient.
Your local power company can help.

Producing Electricity

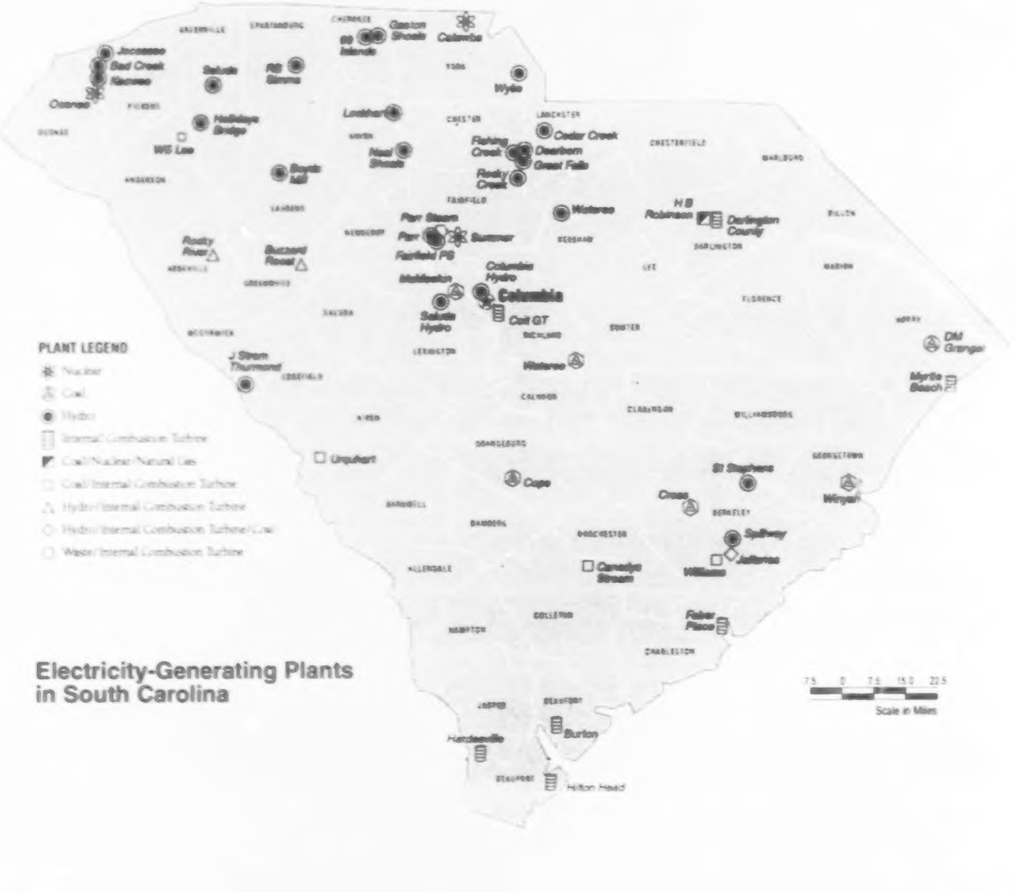

ELECTRICITY
GENERATOR
TURBINE
BOILER
Coal
Oil
Gas
Nuclear Reaction (Uranium)
FUEL SOURCES FOR GENERATING ELECTRICITY

PRODUCING ELECTRICITY
Several fuel sources are used in South Carolina's electricity generating plants. Each of these fuel sources provides the heat that is used to create steam. This steam provides the power to turn the turbine that spins the magnet inside the coil, creating electricity. In South Carolina, nuclear fission creates the heat that provides about 60 percent of the electricity.

In hydroelectric facilities, no heat is needed. Falling water is used to spin the turbine.

POWER IN SOUTH CAROLINA

Graphs, charts and illustrations about energy in South Carolina


Greenville
Spartanburg
Cherokee
Gaston Shoals
99 Islands
Catawba
Jocassee
Bad Creek
Keowee
Oconee
Saluda
PB Simms
York
Wylie
Pickens
Oconee
Hollidays Bridge
WS Lee
Lockhart
Union
Chester
Lancaster
Cedar Creek
Chesterfield
Marlboro
Neal Shoals
Fishing Creek
Dearborn
Great Falls
Rocky Creek
Anderson
Boyds Mill
Laurens
Fairfield
Wateree
H B Robinson
Darlington County
Dillon
Parr Steam
Parr
Fairfield PS
Summer
Newberry
Kershaw
Darlington
Rocky River
Buzzard Roost
Abbeville
Greenwood
Columbia Hydro
McMeekin
Columbia
Saluda Hydro
Coit GT
Lee
Marion
Florence
Saluda
McCormick
Richland
Sumter
Horry
DM Granger
Lexington
J Strom Thurmond
Edgefield
Wateree
Myrtle Beach
Calhoun
Aiken
Clarendon
Williamsburg
Orangeburg
Urquhart
Georgetown
St Stephens
Cope
Cross
Winyah
Barnwell
Berkeley
Bamberg
Dorchester
Spillway
Jefferies
Allendale
Canadys Steam
Williams
Faber Place
Colleton
Hampton
Charleston
7.5 0 7.5 15.0 22.5
Scale in Miles
Jasper
Beaufort
Burton
Hardeeville
Beaufort
Hilton Head

PLANT LEGEND

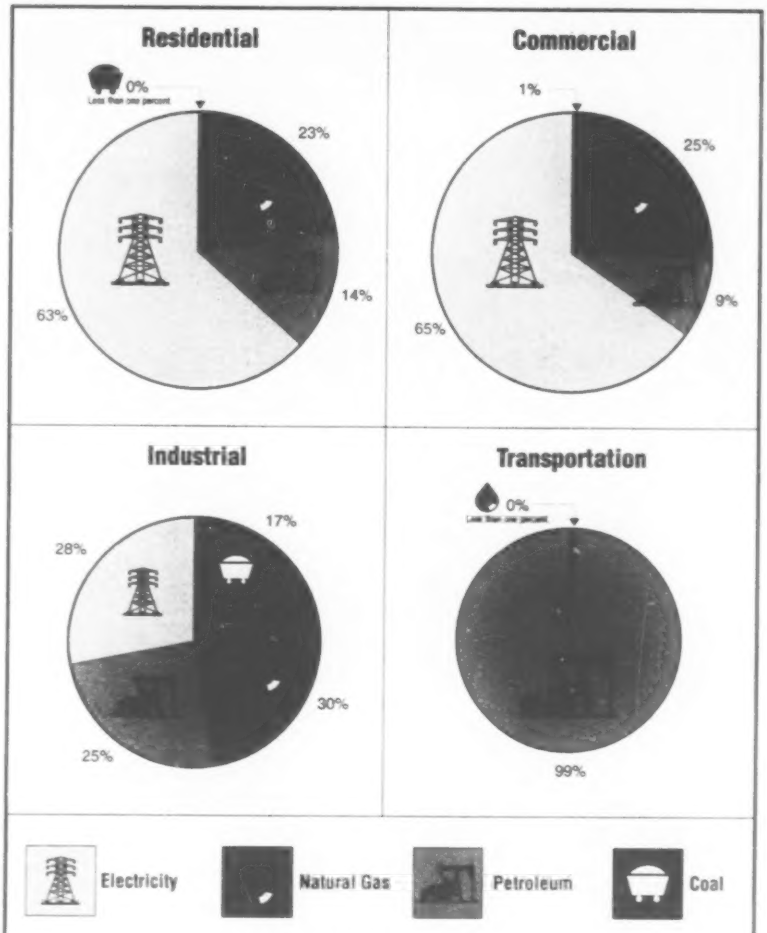
- ✲ Nuclear
- Coal
- ● Hydro
- ▤ Internal Combustion Turbine
- ◪ Coal/Nuclear/Natural Gas
- ☐ Coal/Internal Combustion Turbine
- △ Hydro/Internal Combustion Turbine
- ◇ Hydro/Internal Combustion Turbine/Coal
- ○ Waste/Internal Combustion Turbine

Electricity-Generating Plants in South Carolina

BEST COPY AVAILABLE

STUDENT HANDOUT

South Carolina's
net energy consumption
by sector – 1992



Source: US Department of Energy, *State Energy Data Report 1992*

Use the charts above to answer these questions about energy in South Carolina.

1. What are the sectors or categories of energy consumers in South Carolina?

____

2. What are the four types of energy resources listed on the charts?

____

3. Which sector uses the largest percentage of petroleum? ____________________

Why would this sector use so much petroleum? ____________________

4. Which sector uses the largest percentage of natural gas? ____________________

STUDENT HANDOUT

Getting to know electricity in South Carolina

Use the information on the following pages of the *Energy FactBook* to answer these

1. How many power plants are there in South Carolina? ______________________________

2. How many nuclear plants are there in South Carolina? ____________________________

2. What percentage of South Carolina's electricity is generated by nuclear power? ______________

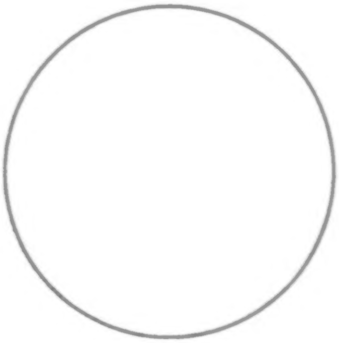
3. How many exclusively hydro plants are there in the state? ________________

4. What percentage of the state's power comes from plants fueled by petroleum, natural gas or water?

____

5. What investor-owned company provides the most power to the people in this state? ____________

6. Draw and label a pie chart that shows how electricity is generated by SCE&G.



7. What is South Carolina's public utility company?______________

8. How many people are served by this public-owned utility? __________

9. What percentage of electricity generated in the state is used by private homes? ______________

10. What are "electric cities" in South Carolina? __________________________________

Electricity In South Carolina

reprinted with permission from the *Energy FactBook*

South Carolina's use of electricity continues to increase. In the past twenty years, the state has more than tripled the amount of electricity produced.

As the state's economy has grown, so has its need for electricity. As the map shows, the state has 59 power plants.

PLANT LEGEND

Electricity-Generating Plants in South Carolina

In 1991, these plants generated almost 80 billion kilowatt-hours of electricity **Nearly two-thirds of this electricity came from nuclear power plants.** Coal-fired plants produced almost all of the remaining electricity Less than 5% of our electricity comes from plants fueled by petroleum, natural gas or water.

South Carolina's Utilities

South Carolina is served by investor-owned and municipally-owned utilities as well as rural electric cooperatives.

The Investor-Owned Utilities

Four investor-owned utilities serve South Carolina: South Carolina Electric & Gas (SCE&G), Duke Power Company, Carolina Power & Light (CP&L), and Lockhart Power. These utilities have an assigned service territory, an obligation to serve, and are regulated by state commissions and federal regulations. Each is owned by millions of small investors who have stock in the company.

With nearly half a million customers (447,000 in 1991), SCE&G is the primary supplier of electricity in our state. It maintains 17,000 miles of transmission lines and 3,000 miles of distribution lines. Of the electricity generated by this utility, 66% comes from coal, 25% from nuclear fuel, and 9% from water power, internal combustion or other sources.

Duke Power Company, headquartered in Charlotte, NC, serves nearly 340,000 customers in South Carolina's Upstate region. Duke also operates more than 2,000 substations and switching stations interconnecting some 13,000 miles of transmission lines and 67,000 miles of distribution lines.

Over 60% of the electricity produced by Duke Power comes from nuclear fuel. Thirty-seven percent of the electricity is generated by coal and 3% comes from water power, internal combustion or other sources.

Carolina Power & Light, also headquartered in North Carolina, operates two plants in our state, both in Hartsville. CP&L's service area covers one-fourth of South Carolina, in the Pee Dee region. Of the electricity generated by CP&L, 47% comes from nuclear fuel, 40% from internal combustion or turbine, and 12% from coal.

Lockhart Power is the smallest of the investor-owned utilities in our state. It serves just over 5,000 customers, primarily in Union County. All of the electricity generated by this utility comes from hydropower.

Santee Cooper: South Carolina's Public Utility

The South Carolina Public Service Authority, known as Santee Cooper, is the state's public utility. It was created in the 1930's to bring electricity to rural areas.

When it started, less than 3% of South Carolina's farms had electricity. One decade later, Santee Cooper was bringing electricity to 91% of the farms in the state.

In 1990, Santee Cooper produced some 13.6 billion kilowatt-hours of electricity for its one million customers. This makes Santee Cooper the fourth largest public power system in the country.

THE ELECTRIC COOPERATIVES

Much of Santee Cooper's electricity is distributed by rural electric cooperatives. These cooperatives are customer-owned, nonprofit utilities. Their mission is to bring electricity to remote areas at the lowest possible cost.

Today, cooperatives reach nearly one-third of the citizens of our state in both rural and urban areas. To reach customers in rural areas, the cooperatives have to use a lot of power lines. In fact, over 53,000 miles of wire are used to bring electricity to South Carolina's rural citizens.

SOUTH CAROLINA'S ELECTRIC CITIES

South Carolina also has 21 municipal electric utilities. These 21 "electric cities" provide electricity as a public service. Local governments purchase electricity at wholesale prices and then distribute the power to their customers at retail rates. The distribution system is owned by the city.

The municipal electric utilities are financed by bonds. Bonds are certificates of debt which are issued by the municipal government guaranteeing payment of the original investment plus interest by a specified future date.

HOW WE USE ELECTRICITY

The industrial sector uses most of the electricity produced in South Carolina. Almost half of the electricity generated goes to operate factories and mills. Most of South Carolina's industrial users of electricity are concentrated in the Piedmont counties of Greenville, Spartanburg and Anderson.

Nearly one-third of the energy produced in the state is used in private homes. Everything from the basic (refrigerators) to the frivolous (ice cream makers) runs on electricity.

A little over one-fifth of South Carolina's electric energy goes to commercial customers. Again, the biggest users are in Greenville and Spartanburg counties. Charleston County is one of the biggest users of both commercial and residential electricity.

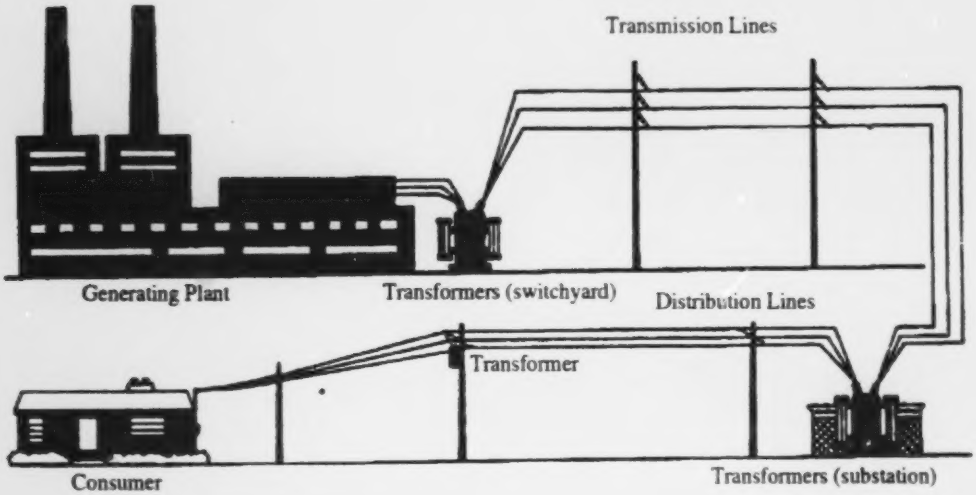
CONCLUSION

Electricity is an important part of South Carolina's energy past, present and future. Its utilities provide electricity to even the most rural areas. Modern technologies including the use of nuclear fuel and pumped-storage allow us to produce energy to meet the needs of all sectors Of the South Carolina economy.

STUDENT HANDOUT

How Electric Energy is Transformed, Transmitted and Distributed

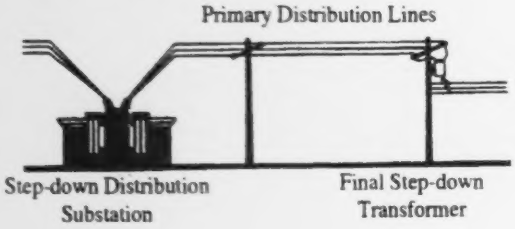
Use these illustrations to answer the question below.

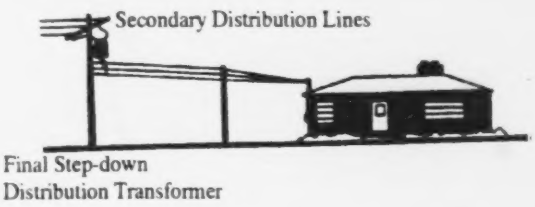

Transmission Lines
Generating Plant
Transformers (switchyard)
Distribution Lines
Transformer
Consumer
Transformers (substation)

South Carolina's power plants generated almost 80 billion kilowatt-hours of electricity in 1991. Power companies in the state maintain more than 150,000 miles of transmission and distribution lines.

Electricity, as it comes from a turbine generator, cannot be sent directly to your house. This is because electricity flows through a wire much like water flowing through a garden hose. Unless there is pressure pushing the water through the hose, it will not comes out the other end. To get electricity through the wires to your home, it must be pushed under pressure. Voltage is the term that describes this pressure. Outside the power plant, **the switchyard has transformers that increase the voltage**. This increase in **voltage** gives the power the push it needs so that it can travel the long distances to reach homes and factories many miles away. The wires that carry this high voltage are called **transmission lines**.

When the electricity gets to your neighborhood, its voltage is too high to use in homes and factories. **At a substation, transformers reduce the voltage**. The electricity leaves the substation along wires called distribution lines. These are the lines along the streets in neighborhoods. Before the electricity comes into your house, the voltage is reduced one more time by a pole transformer.


Primary Distribution Lines
Step-down Distribution Substation
Final Step-down Transformer


Secondary Distribution Lines
Final Step-down Distribution Transformer

True/False

T F 1. Transformers are used to *increase* and *decrease* the voltage of electricity as it is sent from a power plant to your home.

T F 2. At substations the voltage of electricity is changed.

T F 3. Voltage is increased when power moves from transmission lines to distribution lines.

STUDENT HANDOUT

Power In South Carolina

Use the charts, graphs, and illustrations in your handout to answer these questions about Power in South Carolina.

CIRCLE THE ANSWER

1. South Carolina depends on fossil fuels from
   (a) coal mines in South Carolina (b) mines in other states (c) nuclear power plants.
2. Residents use
   (a) 20% of the state's energy (b) 50% of the state's energy (c) 70% of the state's energy.
3. Fossil fuels make up
   (a) two-thirds of the state's energy (b) one-third of the state's energy (c) half of the state's energy.
4. The Foster Wheeler plant generates power from
   (a) nuclear fission (b) coal (c) municipal waste.

TRUE OR FALSE

5. _____ The residential sector in South Carolina uses more natural gas than electricity.
6. _____ The commercial sector in South Carolina uses more electricity than the residential sector..
7. _____ There are more hydroelectric plants in South Carolina than nuclear plants.
8. _____ The transportation sector is the single largest user of petroleum products.
9. _____ Transformers are used in various places in distributing power from the generation station to the consumer.

CHECK THE BOXES THAT CORRECTLY ANSWER THE QUESTIONS. YOU MANY CHECK MORE THAN ONE FOR EACH.

10. The fuel source for generating heat in the production of electricity can be

_____ Coal _____ Nuclear fission _____ Natural gas _______ Oil.

11. Check the kinds of problems caused by burning oil and coal.

_____ Air pollution _____ Water pollution

_____ Land destruction _____ Waste products

_____ Noise pollution

12. Match the fossil fuel with its most important use:

_____ coal a. generation of electricity

_____ petroleum b. heating houses and stores

_____ natural gas c. transportation

Energy from the Sun

Preparation Time: Easy-To-Do Moderate **Extensive**

Grade: 6 – 8
Focus: How much energy comes to us from the sun.
Subject: Science, Math
Materials: See list below
Teaching Time: One class period
Vocabulary: Solar energy, photovoltaic, active solar system, passive solar system

Learning Objectives

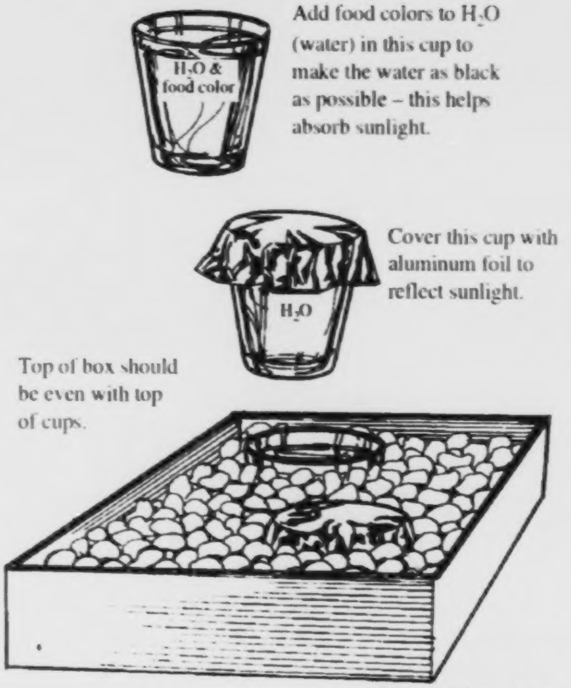
In this activity, students will:

- measure the amount of solar heat that comes from the sun
- describe ways this energy might be used to help reduce our dependence on traditional fossil fuels and nuclear power.

Materials

This activity works well for small group of students. For each student group performing the experiment, you'll need:

- two styrofoam cups
- two thermometers
- food coloring
- aluminum foil
- measuring cup
- metric ruler
- watch with second hand
- insulation materials (packing foam, shredded newspaper, etc.)
- cardboard box (should be the same height as the cups, trim the box if needed)
- cold water
- access to direct sunlight.



Add food colors to H_2O (water) in this cup to make the water as black as possible – this helps absorb sunlight.

Cover this cup with aluminum foil to reflect sunlight.

Top of box should be even with top of cups.

Pack insulation into all spaces around cups.

Background

excerpts from the *Energy FactBook, A Resource for South Carolina*

The sun is our most powerful energy resource. It heats our planet and nourishes the plants we eat. Without the sun, we could not exist.

The energy from the sun, or **solar energy**, is there for the taking. It is free and never runs out. If we could harness the sun's energy that falls on one square meter of the Earth's surface for one hour, we could light a city for one year. Also, the energy from the sun poses no environmental hazards.

DOWN TO EARTH

The U.S. Department of Energy's National Renewable Energy Lab is testing a prototype integrated photovoltaic roofing system. By incorporating the panels in the roof, it eliminates the cost of installing panels.

source: *Solar Today, August 1994*

The Challenge of Tapping the Sun's Energy

With these many advantages, why aren't we using **solar energy** to meet all our energy needs? The answer is that tapping the sun's energy is not a straightforward process.

To effectively use the sun, it must be constantly available. Yet, even under ideal weather conditions, the sun does not shine 24 hours a day, 365 days a year. To be useful, sunlight must be collected, moved to where it is needed and stored. This is no easy challenge.

People have been using the sun's energy for thousands of years for space and water heating purposes. With the beginning of the space age, scientists were able to develop a system that converts sunlight into electricity. This is called a **photovoltaic** system.

In all solar power systems, the system must face the sun to work. We know that the sun moves across the sky during the day from east to west. To get the maximum amount of energy from the system, it should face due south, or only slightly east or west of south.

Active Solar Systems

Active solar systems use mechanical equipment such as pumps and fans to move energy around. There are two types of active systems, one for space heating and the other for water heating.

A house using active space heating will have to face south, with most of its windows on the south wall. This allows winter sunlight to enter the house, thereby heating the air inside.

When sunlight passes through glass into an enclosed space, the wavelength of the light changes. This new wavelength can not pass back through the glass, thereby entrapping it in the house. This is known as the greenhouse effect.

Equipment is used to collect heat and circulate it.

For solar water heating, a collector is mounted on the roof (facing south). A pump circulates water through copper pipes to heat it.

Passive Solar Systems

Passive solar systems do not use any mechanical equipment to move the energy. Tile, concrete, brick and water are used to absorb and store heat that is then released at night.

To be most effective, windows in a passive solar system must face south. In addition, insulation should be placed around the glass to reduce heat loss. Windows, doors, and walls need to be free of leaks so that trapped heat stays trapped.

Outside landscaping is another important part of passive solar systems. For example, evergreen trees that won't lose their leaves in winter can be planted on the north side of a home to provide winter protection. Trees that lose their leaves in winter can likewise be planted on the south side of a home to give it access to winter sunlight and to protect it from hot, summer sunshine.

Photovoltaic Solar Systems

Photovoltaic systems convert radiant energy from the sun into electricity. While photovoltaic technology has been around for 150 years, its actual development did not occur until 1954. It was first used in 1958 to provide electric power for US spacecraft and satellites.

The cost of producing electricity through photovoltaic technology has dropped significantly, from more than $50 per **kilowatt** to less than 30 cents per kilowatt.

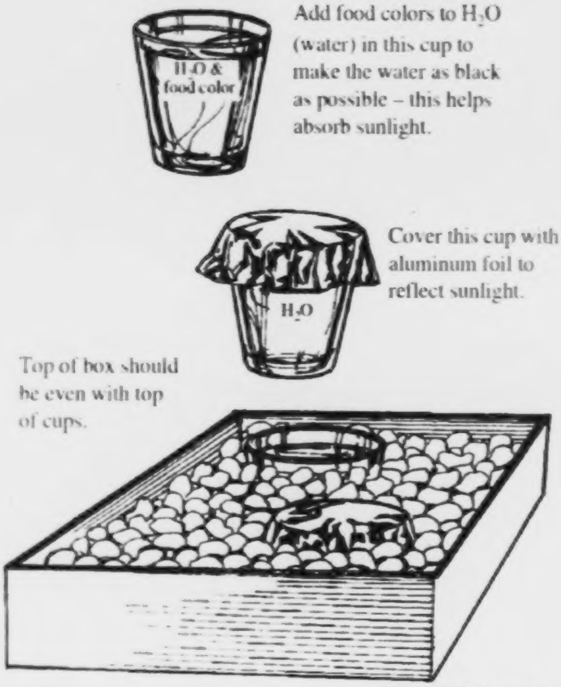
Today, photovoltaic systems are used to light road signs and bus shelters. Researchers developing electric cars are also using the technology.

Learning Procedure

1. Review with the class the background information on solar energy. **Ask:** How can we measure solar energy? *(Solar energy is measured as heat, or calories.)*

2. Have students work in small groups to perform this experiment to measure solar energy. Have each group record their results.

3. To set up the experiment, have students:
   - Fill two foam cups with a measured amount of very cold water. (*Set a standard amount for students to use based on the size of the cups.*)
   - To one of the cups of water, add several drops of food coloring to turn the water dark. (*Make the water as close to black as possible. Black absorbs sunlight.*)
   - To the other cup of clear water, cover the top with a piece of aluminum foil. (This foil will reflect the sun.)
   - Place the cups in the cardboard box. *(Be sure to trim the box if necessary so that the height is the same as the cups.)*
   - Add insulation material around the cups. *(See illustration.)*
   - Place the box in the sun for 10 minutes. Noon to 1 p.m. is usually the hottest time of the day.



Add food colors to H_2O (water) in this cup to make the water as black as possible – this helps absorb sunlight.

Cover this cup with aluminum foil to reflect sunlight.

Top of box should be even with top of cups.

Pack insulation into all spaces around cups.

   - After 10 minutes, stir the water in the cups with the thermometers and record the temperatures. (*Note: these measurements should be taken at the same time.*)
   - Use these results to do the following calculation to find out how many calories, or the amount of solar heat, received on 1 square centimeter in one minute at your location.

Calculation:

Area = $\frac{\pi d}{4}$ = ___________ square centimeters

Calories = $\frac{\text{ml of } H_2O \text{ in 1 cup} \times \text{difference in temperature of both cups after being in the sun for 10 minutes}}{\text{Area (square centimeters) of water} \times 10}$

The "calories" calculation is the same amount of solar heat received on 1 square centimeter in 1 minute at your location. Multiply x 10,000 to get results for 1 square meter.

Scientist have measured the amount of solar energy beyond our atmosphere at about 2.0 calories per square centimeter per minute. About 1.5 calories per square centimeter per minute reaches earth after passing through atmosphere. This is the Solar Constant.

4. After the experiment, have students consider how this solar energy might be applied to their everyday lives. What inventions or modifications to existing systems do they see as practical for using solar energy. For example, could passive solar energy be used effectively by schools, since most school buildings are not used at night? What about electric school buses? Have students explain their idea and how it would save nonrenewable energy resources.

Extension Activity

A great way for your students to see solar power in action is to participate in a **Junior Solar Sprint** competition. A model solar car competition for middle school science students, Junior Solar Sprint offers students a hands-on experience with a photovoltaic system.

In this annual competition, 6th, 7th and 8th grade students design, build and race model cars powered by solar energy.

Student teams are provided a kit which includes a motor and the polar panel. The rest of the car is made from any other materials at student description. Students are encouraged to use math and science principles together with their creativity in a fun, hands-on educational experience.

Participating schools and districts receive support throughout the process from engineers, parents, teachers and volunteers.

The goal of the Harmony Project, the coordinator for the Junior Solar Sprint, is to reach out statewide with this competition. The competition schedule begins in the fall (Nov. - Dec.) with the selection of host sites, volunteers, schools, and youth groups, and wraps up in the summer (May - June) with the school and area races.

Junior Solar Sprint was created by Argonne National Laboratory. Major funding has been provided by the U.S. Department of Energy. For more information contact. The Harmony Project, P.O. Box 21655, Charleston, SC 29413, (803) 577 2103, or the State Energy Office, 1 800 851 8899.

Just Do It

Select solar powered calculators
and other solar powered items.
They save energy and reduce waste
and you never have to
replace batteries!

MYTHS AND MISPERCEPTIONS ABOUT SOLID WASTE

1. Many of the things we throw away decompose in the landfill.
(Actually, very little decomposes in the landfill because there is little air and no sunlight.)

2. When you see a recycle symbol on a product, it means that the product is recyclable.
(No. For example, the chasing arrows symbol currently on plastic items does not necessarily mean that the plastic is recyclable. It is important to know what is recyclable in your area and see that it gets recycled.)

3. When a product is advertised as "Earth-friendly," it means that it is better for the environment than other products.
(On packages and labels, terms like "Earth-friendly" are meaningless. Look for products that last, those that are reusable, those made from recycled materials, and those that are recyclable in your area.)

4. Recycling is just a fad. Recycling is a new idea that will go away.
(Before the 1920s, 70 percent of the nation's cities ran programs to recycle select materials. During World War II, industry recycled and reused about 25 percent of the waste stream. Our current national recycling rate is about 17 percent, 16 percent in South Carolina. The national and South Carolina recycling goals are 25 percent.)

Recycle Word Search

T	I	O	R	E	L	C	A	R	D	B	O
R	R	S	B	I	A	T	W	F	E	G	A
A	E	E	O	Q	I	D	N	C	P	A	R
S	T	V	E	L	R	M	R	P	O	R	D
H	T	A	J	E	G	U	M	L	S	B	N
R	I	P	T	C	O	U	X	A	I	A	L
G	L	A	S	S	N	T	U	S	T	G	R
E	W	H	E	I	T	I	N	T	K	E	E
B	L	R	M	Z	O	E	F	I	R	L	P
S	D	U	P	L	I	R	E	C	Y	C	A
M	L	A	N	D	F	I	L	L	B	A	P
A	E	N	E	R	G	Y	T	N	E	W	S

This word search contains many recycling words that are hidden. They may be spelled forward, backward, up, down and around corners! How many can you find?

ALUMINUM
TREE
LITTER
GLASS
CARDBOARD
WATER

AIR
NEWSPAPER
RECYCLE
DEPOSIT
RESOURCE
STEEL
GARBAGE

TRASH
OIL
TIN
ORE
ENERGY
LANDFILL

Each year, Americans generate millions of tons of trash in the form of wrappings, bottles, boxes, cans, grass clippings, furniture, clothing, and much more. Over the years, we have gotten used to "throwing it away," so it's easy to understand why there's too much trash and not enough acceptable places to put it.

In the United States, we generate about 200 million tons of **municipal solid waste**, this is the garbage picked up from our homes.

In 1995, South Carolina's 3.6 million residents generated 3.8 million tons of municipal solid waste and 2 million tons of other solid wastes (industrial, construction and demolition debris, sludge, yard trash) and collected 1.1 tons of recyclables. Also, about 300,000 tons of solid waste were incinerated in solid waste combustion facilities. This gives South Carolina an average of 5.6 pounds of municipal solid waste per person per day. If all waste disposed (including industrial waste) is averaged into the equation, then each South Carolinian is responsible for about 8.5 pounds of waste per day.

As a state and a nation, we can't solve the solid waste dilemma just by finding new places to put trash.

To manage all of this trash safely and effectively, communities are using **integrated waste management systems** that combine the strategies of waste reduction, recycling, and disposal to manage waste.

The priorities of the United States Environmental Protection Agency (U.S. EPA) in its solid waste management strategy are:

- **reduce waste** by preventing its creation
- **recycle and compost** as much as possible
- **incinerate waste** or treat it in other ways to reduce its volume
- **landfill waste** as a last option.

Recyclables Collected in South Carolina

1995

Recyclable	Tons Collected
Glass	50,117
Metal	81,588
Other	514,459
Paper	125,478
Plastic	12,821
Banned Items (car batteries, white goods, motor oil)	331,270

source: 1995 South Carolina Solid Waste Management Annual Report

The U.S. EPA challenges us to reduce and recycle at least 25 percent of municipal solid waste. In 1990, South Carolina's recycling rate was about 5 percent, in 1995 it was 16 percent. South Carolina's goals are, by 1997, to reduce the amount of garbage by 30 percent and to recycle approximately 25 percent of what we would otherwise throw away.

What's In Our Garbage Can

(percentage by weight)

	SC Averages	National Averages
Plastics	11%	8%
Paper	33%	40%
Glass	7%	7%
Organics	36%	25%
Inorganics	10%	9%
Other	4%	11%

The solid waste stream characterizations include residential, commercial, industrial, agricultural, governmental, and all other solid wastes that are disposed in municipal solid waste landfills.

source: 1993 South Carolina Solid Waste Management Plan

Americans produce nearly three times more solid waste annually than many other countries, and we throw most of it away.

Tips for Reducing Solid Waste from the U.S. EPA

Reduce ...

1. Reduce the amount of unnecessary packaging.
2. Adopt practices that reduce waste toxicity (harmfulness.)

Reuse...

3. Consider reusable products.
4. Maintain and repair durable products.
5. Reuse bags, containers and other items.
6. Borrow, rent or share items used infrequently.
7. Sell or donate goods instead of throwing them out.

Recycle...

8. Choose recyclable products and containers and recycle them.
9. Select products made from recycled materials.
10. Compost yard trimmings and some food scraps.

Respond...

11. Educate others on source reduction and recycling practices. Make your preferences known to manufacturers, merchants and community leaders.
12. Be creative – find new ways to reduce waste quantity and toxicity.

Did You Know...

Congress approved the U.S. EPA's 1995 budget at $7.25 billion, a 9.5% increase compared to 1994.

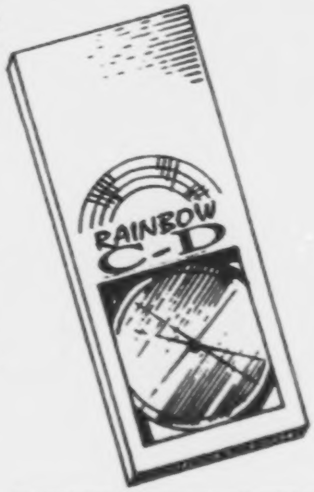
WHAT IS SOUTH CAROLINA DOING ABOUT SOLID WASTE?

South Carolina has comprehensive laws and regulations to protect the environment. The 1976 S.C. Code of Laws includes the Litter Control Act, the Pollution Control Act, the Mining Act, and other regulations. **The South Carolina Solid Waste Policy and Management Act**, signed into law on May 27, 1991, is designed to:

1. Protect public health and safety, to preserve the environment of the state, and to recover resources that have usefulness
2. Establish and maintain a cooperative program to help local governments with solid waste management
3. Require local governments to plan for and provide efficient, environmentally acceptable solid waste management services and programs
4. Promote the establishment of resource recovery systems that preserve and enhance the quality of air, water, and land resources
5. Ensure that solid waste is transported, stored, treated, processed, and disposed in a manner that protects human health, safety, and welfare, and the environment
6. Promote the reduction, recycling, reuse, and treatment of solid waste, and the recycling of materials that would otherwise be disposed as solid waste
7. Encourage local governments to promote efficient and proper methods of managing solid waste
8. Promote the education of the general public and the training of solid waste professionals to reduce the generation of solid waste, to ensure proper disposal, and to encourage recycling
9. Encourage waste reduction and recycling programs through planning and technical assistance, grants and other incentives
10. Encourage the development of the state's recycling industries by promoting markets for recycled items
11. Establish a leadership role for the state in recycling efforts by requiring state agencies to recycle and by encouraging state purchase of recycled goods
12. Require counties to develop and implement source separation, resource recovery, or recycling programs or improve existing programs so that valuable materials may be returned to productive use, energy and natural resources conserved, and the useful life of solid waste management facilities extended
13. Require local governments and state agencies to determine the full cost of providing storage, collection, transport, separation, treatment, recycling, and disposal of solid waste in an environmentally safe manner
14. Encourage local governments to pursue a regional approach to solid waste management.

No Where is Away

Most Americans have grown up with the idea that when we place trash in our garbage cans, it magically disappears and we no longer need to be concerned about it. But times have changed, and the garbage we *throw away* doesn't *go away*. It is causing our landfills to fill up and – if not handled properly – it pollutes our environment.



We must take responsibility for our garbage. Each citizen, community, state and nation must address this social and environmental problem.

What is Source Reduction?

Source reduction means reducing the amount of waste that each of us creates. Ways to do this are to buy less, reduce packaging, and extend the useful life of products. Besides limiting the amount of waste we produce, source reduction also reduces the overall toxicity of waste created.

An example of how awareness leads manufacturers to produce better packaging is the change in compact discs. In 1990, 20 million tons of CD-related garbage were tossed out. This garbage was caused by the long box used to package CD's. In 1991, manufacturers redesigned CD packages to reduce waste.

Source reduction conserves resources and energy, reduces pollution, and helps cut waste disposal and handling costs. *(It avoids the costs of recycling, composting, landfilling, and incineration.)*

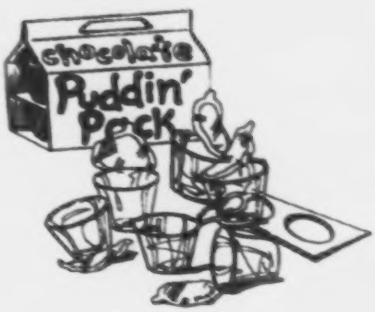
Source reduction is a basic solution to garbage: less waste means less of a waste problem.

Precycling is a term often used along with source reduction. Precycling means reducing the volume of waste at the source by buying items that can be reused or have minimal packaging.

By realizing that purchases relate directly to waste disposal, consumers can reduce waste before it enters the home or school. Both manufacturers and consumers can practice precycling.

Precycling by the manufacturer means creating products that are durable and easily repaired. Also manufacturers can limit the amount of packaging used and can opt for packaging that can be recycled. Packing is the number one component of the nation's waste stream.

While packaging's main purpose is to protect and contain a product, it also prevents tampering, provides information, and preserves freshness. Some packaging, however, is designed largely to sell the product.



Keep in mind: as the amount of product in a container increases, the packaging waste per serving usually decreases.

At the grocery store, there are many examples of excessive packaging. We can precycle by buying items in bulk and then dividing them into smaller servings at home using reusable containers, instead of buying products packaged as "convenient single serve." There are many arguments for and against various kinds of packaging, this makes it very confusing for consumers to make wise choices. **Because each person throws away 440 pounds of packaging each year, the subject of overpackaging is important enough to spend time sorting out the issues.**

No one type of packaging is always correct and each product should be considered individually. However, there are certain trends in packaging that lead to more package waste than others.

Many non-food items tend to be overpackaged. One quick way to determine if a product is overpackaged is to count the separate layers that surround the item. Considering the amount of packaging needed to preserve and protect the item, there are few products that actually need more than one or two layers.

Often, the less essential a product is, the more it tends to be overpackaged, so counting the layers of waste helps identify wastefulness in more ways than one.

Another consideration of wastefulness is the useful life of a package - whether it is refilled, or used briefly and discarded. Refillable containers really are "waste fighters." Today some farm chemical containers, bottled drinking water, cosmetic bottles, and laundry detergents are sold in refillable packages.

Try to learn about the basic material found in a package. Is the resource used a renewable or a nonrenewable resource? Does it contribute to environmental pollution at the processing point?

Are there really good arguments for a particular package style? Consider that for the retailer, the package can do the following things: advertise and promote, simplify stacking and storing, preserve and protect, standardize portions and dispensing, discourage shoplifting or vandalism, and provide instructions or information.

Who pays for the cost of the package and its disposal, and who benefits most from the package? This may lead you to create a packaging solution to benefit the environment, manufacturers and consumers alike.

Reducing Toxicity

Just as important as the amount of trash you throw away is its potential harmfulness. It is important to practice source reduction and precycling to limit the toxicity of waste. While many products containing hazardous components perform useful jobs, many tasks can be accomplished using safer substitutes.

If you need to use products with hazardous components, use only the amounts needed. Leftover materials can be shared with neighbors or donated. Never put leftover products with hazardous components in food or beverage containers.

For products containing hazardous components, read and follow all directions on product labels. When you are finished with containers that are partially full, follow local community policy on household hazardous waste disposal.

Consider Reusing

Although recycling gets a lot of attention, reusing items is the next step in waste management strategy after reducing. Reusing items conserves resources and reduces the amount we throw away. Items that are great for reuse include:

- A sturdy mug or cup used and reused in place of disposables
- Sturdy washable utensils and tableware that can be used and reused instead of plastics designed to be used once and thrown away
- Rechargeable cartridges for printers and copiers
- Cloth napkins, sponges or dishcloths used, washed and reused over and over
- Items in refillable containers,such as detergent bottles made to be refilled
- Rechargeable batteries. These also help reduce toxics in the waste stream.

Reuse Every Day
Many everyday items can have more than one use. Even keeping something out of the waste stream for a short time makes a difference. Besides these ideas, brainstorm things that can be reused at your school and at home.

Reuse paper and plastic bags and twist ties. Reuse bags the next time you shop or reuse bags as trash can liners or for other uses. If you're buying just a few items, perhaps you can skip taking a bag altogether.

Reuse scrap paper and envelopes. Use both sides of paper before recycling it. Save and reuse gift boxes, ribbon and tissue paper.

Wash and reuse many of the plastic and glass food containers you get from the grocery store. These containers can be used to store leftovers as well as buttons, nails and thumbtacks. An empty coffee can makes a fine flower pot.

(Caution: Do not reuse containers that originally held products such as motor oil or pesticides. And never store any potentially harmful products in a reused food container.)

Keep Things Running Smoothly
If maintained properly, many products will last a long time. Long-wearing clothing, tires and appliances are less likely to wear out or break and will not have to be replaced as often.
Tips to keep things running include:

- Consider long-lasting appliances and ones that are easily repaired.
- Keep things in good working order. Properly inflated tires last as much as 10,000 miles longer than sagging ones. Check tire pressure every month.
- Mend clothes instead of throwing them away. Never throw usable clothing away.Donate it.
- Choose toys that will last.
- Consider using new low-energy fluorescent light bulbs. They last longer which means there are fewer bulbs to replace and throw out over time.

Borrow, Rent & Share
Seldom-used items often end up in the trash. Consider borrowing, renting and sharing items such as tools. It saves money and natural resources. When you can, share your newspapers and magazines with others. Many nursing homes and shelters gladly pass these items along to people who will enjoy them at least once more. Magazines are always appreciated at schools.

One Person's Trash Is Another Person's Treasure
Never throw away what might be used again. Donate used goods (in good shape) to thrift stores or other organizations that distribute them. Give hand-me-down clothes to family members, neighbors or the needy.

Choose Recyclable Products and Recycle Them
When you've done all you can to avoid waste, **recycle**. Recycling is probably the most commonly known term in waste reduction. Recycling means collecting used products and turning them into new products.

Industry has been recycling for many years. This **Preconsumer recycling** saves industry money as scrap metal, plastic, paper, and glass are recycled in the production of consumer goods. Often this material is leftover scrap or damaged goods. It has not been contaminated by other trash or mixed with other products. It also takes place on site and does not require the expense of collection and transportation.

The three arrows of the recycling symbol represent the three parts of the **recycling process**.

- **separating and collecting** recyclable products from the trash
- **processing** these products so that they can be substituted for virgin raw materials at manufacturing plants
- **remanufacturing** recyclable materials into useful commodities that consumers purchase.

Postconsumer recycling is the practice of collecting materials after their use and reprocessing them into new products to be used again. According to an article in *Governing* magazine, "A Guide to Recycling," August 1994, "Recycling has become a way of life for many Americans. More than 6,500 communities pick up recyclables set out by more than 100 million residents at curbside."

Recycling technologies are changing and improving every day. An important consideration of recycling is making it economically feasible. While recycling saves energy and natural resources, it is just as important to think about the landfill space that is saved and the pollution that is prevented.

South Carolina
Department of Health and Environmental Control
Office of Solid Waste Reduction and Recycling
1-800-768-7348, 1 800 SO USE IT

Recycling programs vary in how they are run and who runs them.

Household separation/curbside collection is usually run by municipalities and is appropriate for communities with curbside trash collection. This type of program is very convenient. Currently in South Carolina, 645,351 households have curbside collection.

Drop-off centers are the most common form of recycling in the country. In South Carolina, 646,921 households are served by 259 manned drop-off sites. These are designated collection points where people bring recyclables already sorted by type. Of the 46 counties in the state, 33 have some form of drop-off centers for recycling.

Buy-back centers operate like drop-off centers only they pay consumers for bringing in materials. Buy-Back Centers have been successful in collecting large quantities of aluminum. Businesses can recycle through commercial collection companies. These companies collect recyclables from businesses, offices, institutions, schools and industries that generate large quantities of the same waste such as cardboard or white paper.

Choose to Participate

Our landfills are packed with many packages and products that could have been recycled.

Paper, glass, plastic, aluminum, steel, oil, and batteries are the primary targets of most recycling programs.

Get into the Recycling Cycle

Choose products made of materials that are collected for recycling locally. If your community recycles glass but not plastic, choose glass packaging whenever you can and reuse and recycle it.

Participate in community recycling drives, curbside programs and drop-off collections. Call your local or county waste disposal officials for instructions on how to collect and separate materials. These procedures may vary from community to community.

If a recycling program does not exist in your community, participate in establishing one. Work with community officials to determine the most cost-effective recycling options for your area.

Take used car batteries and motor oil to participating collection sites. (For more on used oil recycling see the Used Oil section of this Resource.)

As more businesses and organizations provide collection opportunities, take advantage of them. For example, many grocery stores collect bags and aluminum cans for recycling.
Many businesses are getting into the recycling habit. For example, tenants of the Atrium Building in Columbia, South Carolina, have succeeded in

developing a commercial recycling program that has cut solid waste volume by 40 percent in just one year. Businesses throughout the state are also saving money by buying recycled products such as recycled laser toner cartridges. New cartridges cost approximately $90, while recycled ones average $30. Recycled cartridges also last one-and-a-half times longer.

Buy Recycled

Just as the promotions to "Buy American" have gained our attention, it is important for us to remember to "buy recycled" if recycling is going to succeed as a waste management strategy. Surveys show that 9 out of 10 consumers support recycling, however, until we close the loop by increasing the purchase and manufacture of recycled content products, the solution is not complete.

To promote "buy recycled" the National Recycling Coalition has formed the Buy Recycled Business Alliance, a group of national companies that are committed to increasing their use of recycled content products. Proving what just a fraction of American businesses can do to stimulate the market for recycled products, more than 500 large and small companies in the Buy Recycled Business Alliance spent $10.5 billion on recycled products and materials in 1993.

Bring Recycling Home

Think recycling at the cash register. When you purchase items that are produced or packaged with recycled materials, you close the loop in recycling.

- Look for recycled content by examining labels.
- Buy it back in items with recycled content such as packaging.
- Ask your stores to carry and use more products made from recycled content.
- Learn more about the thousands of recycled products and how you can make recycling work.

Alliance companies are making an effort to increase their recycled content purchases by re-examining their buying habits and setting goals for the future. American Airlines increased the number of items it purchases with recycled content by 18 percent last year.

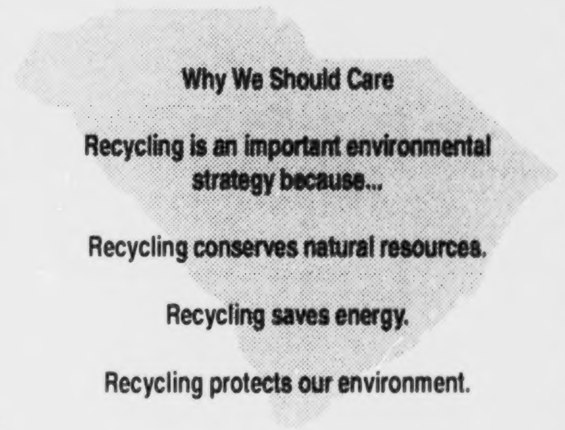
McDonald's Corporation reported that it has spent more than $600 million since 1990 on recycled products including materials for carryout bags, napkins, drink trays, and towels.

The U.S. EPA and the Alliance plan a partnership program, "WasteWi$e," to encourage the business community to reduce waste at the source, collect recyclables, and to purchase and/or manufacture recycled products. For more information, call 1 800 EPA WISE or write WasteWi$e, U.S. EPA, 401 M Street, Mail Code 5306, Washington, DC 20460.

For more information on the Buy Recycled Business Alliance and its publication, *Buy Recycled Newsline*, write The National Recycling Coalition, 1101 30th Street, NW, Suite 305, Washington, DC 20007.

To spur use of recycled paper, President Bill Clinton has signed a new Executive Order on buying recycled products. Clinton's order raises the level of post-consumer content required in recycled printing and writing paper purchased by the federal government to 20 percent by the end of 1994 and 30 percent by 1998. In South Carolina, all government agencies are encouraged to purchase recycled products whenever possible and must establish a source separation and recycling program. The South Carolina Solid Waste Management Plan states that by November 27, 1993, the Governor's Office, the General Assembly, the Judiciary, each state agency and each state-supported institute of higher education shall establish and implement a solid waste reduction program.

Two South Carolina groups, the **Center for Waste Minimization** and the **Recycling Market Development Council**, are available to provide technical assistance to the state's businesses on reuse and to help locate markets for recovered materials and products with recycled content. The Center for Waste Minimization helps businesses that want to use a recovered material in place of a virgin material or that want to recycle their own wastes. Market development can boost the financial return on materials, improving the bottom line of recycling programs.



Why We Should Care

Recycling is an important environmental strategy because...

Recycling conserves natural resources.

Recycling saves energy.

Recycling protects our environment.

What Industry Can Do

Better Product Design

Changes in the design of a product or its packaging, such as making the packaging lighter in weight or smaller or offering a product in a concentrated form, can save transportation costs and packaging costs, and can reduce garbage.

Aluminum cans are a good example of light-weight packaging. Over time, manufacturers of soda cans have decreased the amount of aluminum used per can. In 1976, 23 cans were made from a pound of aluminum; today, 29 cans are made from the same amount. Today, although they retain the same strength and size, glass jars now weigh in 44 percent less than jars used 20 years ago.

Initiatives have been taken by other manufacturers. For example, General Mills reduced the thickness of the plastic bags in cereal boxes to decrease the amount of plastic the company used annually by 500,000 pounds. Procter & Gamble eliminated the packaging for Secret and Sure deodorants, thereby removing about 80 million cartons a year from the waste stream.

Other things that companies can do are to incorporate environmental business policies. For example, offices with high reproduction budgets may consider establishing a double-sided copying policy. After instituting such a policy for client documentation, AT&T estimated that if this policy is followed only 50 percent of the time, the amount of paper used will be reduced by 77 million sheets annually and company costs will decrease by $385,000 a year.

A groundbreaking program to educate the next generation of engineers and product designers to be sensitive to the needs of the environment is taking place the School of Engineering at Grand Valley State University in Michigan. The university is incorporating a concept called Design for Recycling introduced by the Institute of Scrap Recycling Industries, Inc. The project's aim is to foster the design and manufacture of goods that can be recycled safely and efficiently at the end of their useful lives.

Many other universities are incorporating recycling technology and waste management study into their curriculum offerings.

A Consumer's Guide to Environmental Claims in the Marketplace

Excerpts from marketing information provided by Scientific Certification Systems, a leading independent organization certifying manufacturers' environmental claims.

There's no doubt about it. More companies than ever before are considering the environmental implications of the products they produce. And more products than ever carry environmental claims.

1) All products have an impact on the environment. Every product involves the use of resources and energy at some point in its production, use, or disposal. Solid and hazardous wastes may also be generated. Watch out for vague claims like "environmentally friendly" and "safe for the environment." Also be on the lookout for environmentally suggestive packaging which may leave a strong impression but doesn't add up to much.

2) Specific claims are best. Recycled content claims should always indicate an actual percentage.

3) Significant achievements deserve recognition. Not every environmental claim represents an improvement. Some companies have resorted to making irrelevant claims. What about a product that advertises "no CFCs" when CFCs have not been allowed for 15 years? Or what do they mean by "landfill safe?"

4) Claims should be verified. Every company should be able to provide detailed documentation to support the claims they make.

SCIENTIFIC
CERTIFICATION
SYSTEMS

The Benefits of Composting

While many of us see composting as a new idea, it isn't. The Roman Statesman Marcus Cato introduced composting as a way to build soil fertility throughout the Roman Empire more than 2,000 years ago.

Backyard composting of certain food scraps and yard trimmings can significantly reduce the amount of waste that needs to be managed, landfilled or incinerated.

In South Carolina the Solid Waste Policy and Management Act prohibits counties from disposing of yard wastes and land-clearing debris in municipal solid waste landfills after May 27, 1993. Currently there are about 26 registered composting and wood chipping/shredding facilities in the state.

Yard wastes must be handled separately. This means that yard wastes do not belong in the trash. Many communities will still offer curbside pickup of these wastes in special containers so that they can be taken for composting or shredding.

Nature's Recycling

Composting is the natural process of decomposition and recycling of organic material into a rich soil amendment known as compost. When properly composted, yard wastes and some food scraps can be turned into natural soil additives for use on lawns and gardens and used as potting soil for house plants. Finished compost can improve soil texture, increase the ability of soil to absorb air and water, suppress weed growth, decrease erosion and reduce the need for soil additives.

Just as an aluminum can is a valuable resource, so are yard clippings. And yard clippings and food wastes make up about 25 percent of our household waste.

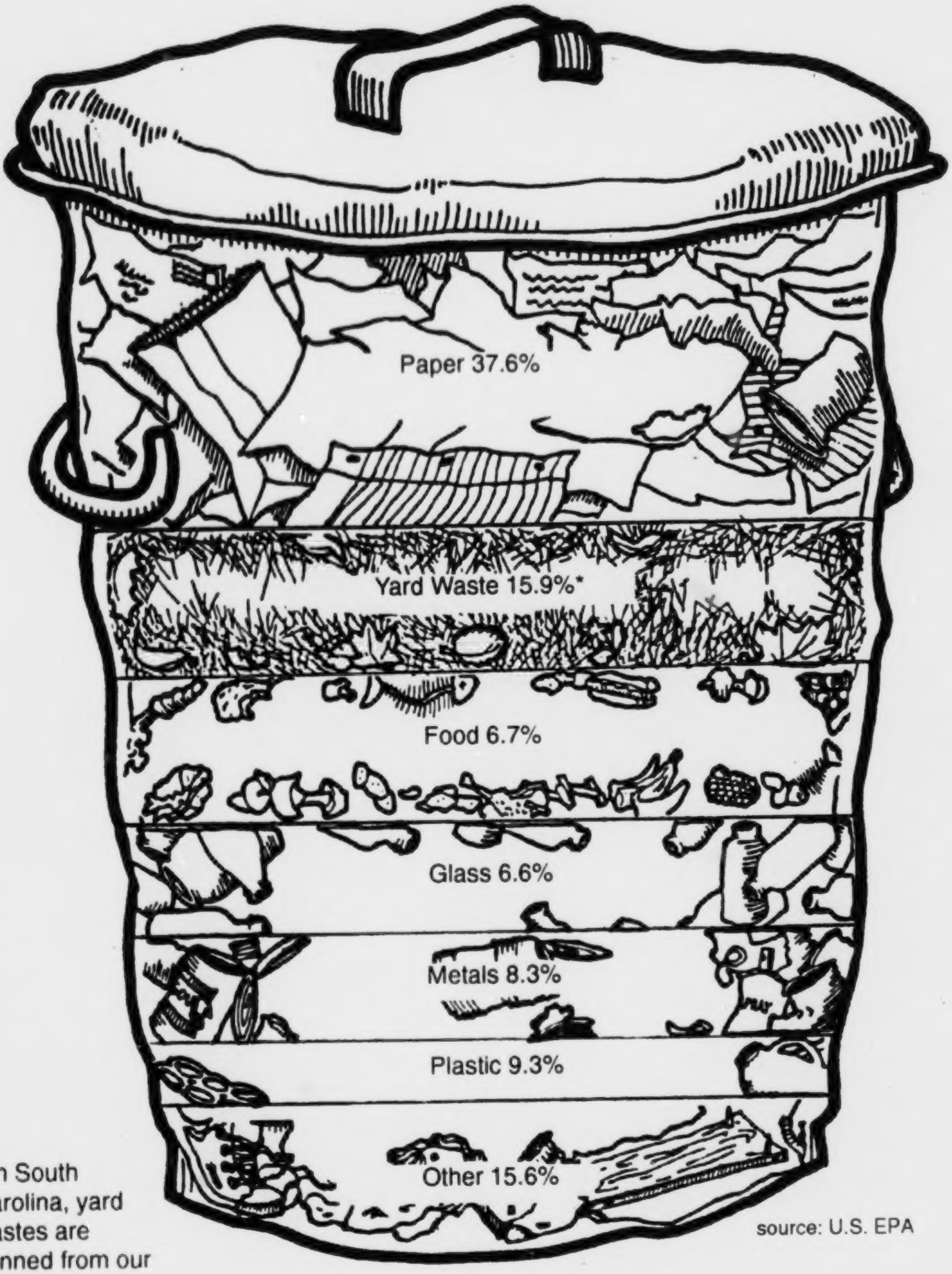
Some people think that composting takes too much time. If you are composting yard clippings, you will only spend about five minutes each week maintaining your compost pile, figure in a few extra minutes if you are including kitchen scraps.

A simple way to compost yard wastes is to allow mown grass clippings to remain on the lawn to decompose and return nutrients back to the soil, rather than bagging and disposing of them.

> "If you are thinking a year ahead, sow a seed.
> If you are thinking ten years ahead, plant a tree.
> If you are thinking one hundred years ahead, educate the people."

These words from a Chinese poet, 500 BC, echo the task ahead as our country works to educate its people about the environment and the role we each play in protecting it. Share information about source reduction, recycling, and composting with others. Write to companies and let them know your preferences for products and packaging that reduce solid waste.

What's in Your Garbage Can?



source: U.S. EPA

* In South Carolina, yard wastes are banned from our landfills.

SARAH CYNTHIA SYLVIA STOUT WOULD NOT TAKE THE GARBAGE OUT

Sarah Cynthia Sylvia Stout
Would not take the garbage out!
She'd scour the pots and scrape the pans,
Candy the yams and spice the hams,
And though her daddy would scream and shout,
She simply would not take the garbage out.
And so it piled up to the ceilings:
Coffee grounds, potato peelings,
Brown bananas, rotten peas,
Chunks of sour cottage cheese.
It filled the can, it covered the floor,
It cracked the window and blocked the door
With bacon rinds and chicken bones,
Drippy ends of ice cream cones,
Prune pits, peach pits, orange peel,
Gloppy glumps of cold oatmeal,
Pizza crusts and withered greens,
Soggy beans and tangerines,
Crusts of black burned buttered toast,
Gristly bits of beefy roasts...
The garbage rolled on down the hall,
It raised the roof, it broke the wall...
Greasy napkins, cookie crumbs,
Globs of gooey bubble gum,
Cellophane from green baloney,
Rubbery blubbery macaroni,
Peanut butter, caked and dry,
Curdled milk and crusts of pie,
Moldy melons, dried-up mustard,
Eggshells mixed with lemon custard,
Cold french fries and rancid meat,
Yellow lumps of Cream of Wheat.
At last the garbage reached so high
That finally it touched the sky.
And all the neighbors moved away,
And none of her friends would come to play.
And finally Sarah Cynthia Sylvia Stout said,
"OK, I'll take the garbage out!"
But then, of course, it was too late...
The garbage reached across the state,
From New York to the Golden Gate.
And there, in the garbage she did hate,
Poor Sarah met an awful fate,
That I cannot right now relate
Because the hour is much too late.
But children, remember Sarah Stout
And always take the garbage out!

Shel Silverstein - Where the Sidewalk Ends

Hey...
Sarah Cynthia, What about recycling and composting? This way there's a lot less garbage to take out.

A Guilt-Free Guide to Garbage

Excerpts from *Consumer Reports* magazine, February 1994

Global warming and the thinning ozone layer are abstract threats that make many consumers feel helpless. Garbage however, brings environmental issues close to home. Spurred by public concern and local regulations, consumers are dutifully filling recycling bins, buying products made of recycled materials, and avoiding wasteful packaging.

RECYCLING

IS IT WORTH THE EFFORT?

"In the first week in November 1992, more adults took part in recycling than voted," says Jerry Powell, editor of *Resource Recycling* magazine and chair of the National Recycling Coalition.

Clearly, recycling has taken hold.

Recycling does help keep garbage out of landfills and incinerators, both of which pose environmental problems. But recycling has its limitations. It will never fully replace other methods of garbage disposal. Moreover, the greatest problems with landfills and incinerators come from the disposal of toxic metals and hazardous wastes – and so far recycling has done little to solve those problems.

Recycling's greatest advantage may not be at the dump, but at the factory. Making new products out of recycled materials almost invariably produces less air and water pollution, and uses up much less energy, than making the products out of virgin material.

On the national level, recycling is becoming more cost-effective as garbage disposal becomes more expensive. New regulations from the U.S. Environmental Protection Agency set strict guidelines on how and where landfills can be built. These regulations will raise the price of sending trash to landfills – not only because new landfills are costly to build, but because many old ones will be shut down. According to one recent estimate, about 20 percent of all the country's landfills may have to close under the new regulations.

DOES RECYCLING PAY?

While American cities and towns have increasingly looked to recycling programs as an option, they have often found that the economics of recycling works against them.

First, there's the initial investment in extra trucks and sorting equipment and the cost of paying people to run them. Picking up recyclables costs more than picking up the same quantity of trash. Most municipalities collect their materials comingled, that is, jumbled together in one bag or bin. These eventually make their way to a Materials Recovery Facility, or MRF, where recyclable materials are sorted and sent on to brokers or directly to the factories that will use them. With their heavy machinery and their dependence on hand-sorting materials such as paper, plastic, and glass, MRFs are expensive to build and to run.

Together the costs of pickup and processing easily outstrip the current value of recycled material. A widely quoted study by Waste Management of North America Inc., the nation's largest private garbage hauler and landfill operator, found that the company spends an average of $175 a ton to pick up and sort the recyclables that most communities include in their curbside programs – glass, aluminum, steel cans, newspaper, and plastic – but receives only $40 a ton for them.

REPLACING RAW MATERIALS

"The problem with throwing away a ton of cardboard is not that it's going to hurt somebody if you burn it or bury it," says John Schall, an environmental economist. "The problem is that you have to make the next ton of cardboard by cutting down trees, which has immensely greater environmental impact than disposing of it."

Many analysts have now compared the environmental impact of using virgin raw materials versus the environmental costs of collecting, sorting, and remanufacturing recycled materials. In almost every case, using recycled materials has substantial environmental benefits.

An analysis done by the Tellus Institute, a Boston environmental consulting group, found that a major benefit of using recycled materials is that it saves energy. And energy use is responsible for the major environmental impacts of production: the depletion of nonrenewable resources, the air pollution, the generation of greenhouse gases that may contribute to global warming, and so on.

If using recycled materials makes so much sense, why haven't manufacturers been doing it all along? In some cases, they have. The aluminum industry discovered the economies of recycling two decades ago, and tissue, cardboard, and boxboard manufacturers have used scrap paper for years. Recycling is built into the steel industry. One of the two major types of steelmaking furnace must have 25 to 30 percent scrap metal to function properly; the other type runs on 100 percent scrap.

Nevertheless, most manufacturing industries are still geared to run on virgin rather than recycled materials, driven by the abundance and low cost of virgin resources in the US.

Factories have a huge infrastructure designed to use virgin materials, and retooling to use recycled materials can be very expensive. When a Canadian newsprint manufacturer, decided to equip its mill to use more than 50 percent recycled pulp, it spent $50-million in Canadian dollars to build an immense new de-inking plant. Union Carbide Inc., one of the nation's suppliers of plastic, had to build a new $10-million factory to recycle bottles made from plastic that it had produced in the first place.

Recently, a consortium of American companies, including Time Inc., the Prudential Insurance Company, Johnson&Johnson, and McDonald's Corp., announced that they were banding together with the encouragement of the Environmental Defense Fund, to increase their own use of recycled paper and to encourage other companies and institutions to follow suit. This effort should get the paper industry's attention: The participating organizations buy more than $1-billion worth of paper and paper products each year.

The next wave in recycling may be spurred by legislation. Many states have passed laws specifying recycled content for newspapers. Last October, a White House executive order required the Federal Government to use only paper that is at least 20 percent recycled fiber. Though the Government accounts for only 2 percent of the total printing and writing paper market, the order is expected to set a de facto standard for similar public and private initiatives, and thus promote the national effort to recycle paper.

The Best Solution: Use Less

A key part of environmental planning is what's being called "source reduction" – design or purchasing choices that reduce the amount of materials used. Many manufacturers have begun selling their products in a form that minimizes packaging. Concentrates of products from fruit juice to laundry detergent have proliferated on supermarket shelves in recent years.

Because all forms of trash disposal – including recycling – have environmental impacts, the best thing a consumer can do is to avoid buying new things whenever possible. When you need to buy, you can practice source reduction by shopping for products that have as little packaging as possible. The next step is to buy products made from recycled content. "The only true recycler is someone who uses recycled products," says Jerry Powell, editor of *Resource Recycling*. Finally, it is important to recycle whatever you can in your community – and do it right.

Does Environmentalism Cost?

–excerpts from GreenWatch, *Good Housekeeping*, Feb. 1993

Traditional thinking is that the environment and the economy are inevitably at odds, that whenever environmental conservation or cleanup takes place, it results in an overall loss of jobs and income. But today, two decades after environmental laws came into play in the United States, there is abundant evidence that virtually all aspects of environmentalism – from pollution control to energy conservation to land preservation – create economic growth.

Since the early 1970s, the U.S. environmental cleanup business has grown at a remarkable 20 percent per year, even during recession, to create two million new jobs in 65,000 new firms with annual sales in 1991 of $130 billion.

"We're in a time of transition not unlike the time our economy changed from horse-driven to engine-powered," says Michael Silverstein, president of Environmental Economics, a Philadelphia consulting firm.

Once-polluting companies often reap the economic benefits of environmental clean-up themselves as their operations become more efficient. A low polluting firm, by definition, is a firm that makes efficient use of its energy and raw materials. By doing just that, firms ranging from IBM to Dow Chemical have cut costs and increased profits. DuPont, for example, reports annual savings of $50 million with its new waste-recovery facilities.

Most important of all, environmental laws and consumer preferences for nonpolluting products have given rise to creative technologies needed to keep the U.S. competitive in the growing $370 billion world market for green goods and services.

A POLL COMMISSIONED BY TIME MIRROR MAGAZINES IN 1992 REVEALED THAT 64 PERCENT OF AMERICAN ADULTS INTERVIEWED SAID ENVIRONMENTAL PROTECTION WAS MORE IMPORTANT THAN ECONOMIC GAIN.

Where the Jobs Are

Green professions are in demand. Manufacturing, production and management strategies are being revamped. Companies are examining every aspect of business from the extraction of raw materials to the disposal of the final product. This includes purchasing, public relations, marketing, financial management, research and development, accounting, sales, personnel, training and strategic management.

1. Environmental consultants are regularly called in when companies are making transitions
2. Banks need environmental investors and researchers
3. Nonprofit organizations provide careers in public interest foundations, think tanks, labor unions and trade associations.
4. Environmental services are needed to promote pollution control and waste management. Businesses are needed to create new technology for clean-ups.
5. The petroleum industry needs environmental engineers, biologists and consultants to perform studies on the environment.
6. Chemical firms also need environmental engineers as well as compliance administrators and product and marketing managers.
7. Organic foods have created a niche in industry. Experts are needed for pest management, organic gardening, retailing of organic food and mail order sales.
8. Environmental lawyers are needed.
9. Insurance companies have had to acquire the cost of cleaning up wastes left by firms carrying their policies. Environmentally aware underwriters are necessary.

These are just a few examples of the edge given to those in the job market that are environmentally educated. There are many more.

Source: *Environmental Careers: A Practical Guide to Opportunities in the '90s*, Lewis Publishers.

RECYCLING PROS AND CONS

Not everything can be recycled easily. Here's a rundown of the different materials that consumers recycle in typical curbside programs.

PAPER

37.5 percent of municipal solid waste

38 percent recycled

Advantages

Recycling paper saves more landfill space than recycling any other material.

Recycling reduces air and water pollution.

Many recycled-paper mills being developed.

Abundant supply of newspaper and cardboard.

New recycling plants can take magazines.

Cheapest of all materials to sort.

Obstacles

Weak markets for mixed paper.

Recycled paper of lower quality than virgin paper for some uses.

Cannot be recycled indefinitely.

Photocopy, laser-printed paper hard to de-ink.

De-inking plants costly to build.

Overview

Paper shows what can happen with a combination of market incentives and good technology.

PLASTIC PACKAGING

3.6 percent of municipal solid waste

6.5 percent recycled

Advantages

Recycling reduces air pollution.

Recycling helps conserve oil andgas.

Obstacles

Nonpackaging plastic is rarely recycled.

Only PET and HDPE recycled in quantity.

Cannot be recycled indefinitely.

Generally not recycled into food containers.

Light weight makes it expensive to pick up.

Automatic sorting equipment expensive.

Some virgin plastics available cheaply.

Some resins difficult to clean adequately.

Overview

Plastics recycling is turning out to be the most difficult to achieve.

CONTAINER GLASS

6.1 percent of municipal solid waste

33 percent recycled

Advantages

Recyclable containers make up 90 percent of discarded glass.

Can be recycled indefinitely.

Can be recycled into food containers.

Labels, food residues burn off in furnaces.

Steady markets for clear and brown glass.

Obstacles

Bottles break during sorting.

Broken glass hard to reuse.

Must be hand-sorted by color.

Poor markets for green glass.

Often contaminated with unusable glass.

Overview

New uses and markets are needed for mixed color and broken glass.

RECYCLING PROS AND CONS

As more and more communities offer recycling, these statistics will change. A steady stream of recycled materials for processing and consumers eager to "buy recycled", encourage industry to invest in manufacturing processes that use recycled materials instead of raw materials.

STEEL CANS

1.5 percent of municipal solid waste
41 percent recycled

Advantages
Recycling reduces pollution, conserves ore.

Can be recycled indefinitely.

Can be recycled into food containers.

Dirt and contaminants burn off in furnaces.

Easy to separate with magnets.

Steel mills already set up to use scrap steel.

Strong market for recycled cans.

Obstacles
None.

Overview
If everything were as easy to recycle as steel, there would be no "solid waste crisis."

ALUMINUM CANS

1 percent of municipal solid waste
68 percent recycled

Advantages
Recycling uses 95 percent less energy than virgin production.

Recycling reduces pollution, conserves ore.

Can be recycled indefinitely.

Can be recycled into food containers.

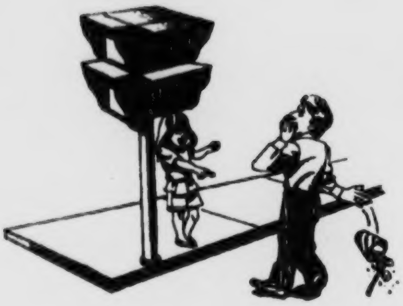
Dirt and contaminants burn off in furnaces.

Well-developed structure for collection and processing.

Strong market for recycled cans.

Obstacles
Light weight makes collection expensive.

Overview
The economics of energy savings made aluminum the first large-scale recyclable and the most valuable recyclable material.



TAKE THE POLLUTION TEST!

- If you walked somewhere, rode your bicycle, or rode public transportation – the bus – (instead of using your car) in the last week, give yourself 10 points.
- If you recycle newspaper, used computer paper, and/or junk mail, give yourself 10 points.
- If you picked up litter in the past week, add 5 points. If you littered in any way, subtract 20.
- If you planted one or more trees last year, add 10 points.
- If you had someone drive you to a destination fewer than two blocks away (such as driving you to a friend's house just down the street), take away 20 points.
- If you visited a natural setting (such as the woods, a stream, or a mountain trail) in the past month, give yourself 10 points.
- If you recycle aluminum cans or foil, give yourself 10 points.
- If your family burns or bags your leaves or grass clippings, take away 10 points.
- If you compost, mulch, or leave yard waste to decompose, add 10 points.
- If your family has a compost pile, add 10 points.
- If you have ever grown a vegetable garden, add 5 points.
- If you forgot to turn off a light, television, or radio in an empty room today (did you turn off your room light before you came to school?), subtract 5 points.
- If you use both sides of a piece of paper before throwing it away, add 5 points.
- If you recycle at home or school, add 10 points.
- If you have worked to clean up the environment in the last year (participated in a paper drive, started a recycling project, picked up trash, etc.), add 10 points.
- If you recycle your used motor oil, add 5 points.
- If you choose not to buy products with excessive packaging, add 10 points.

How did you score?
90 points and above: Great! You are working hard to protect the Earth!
80 - 89 points: You are concerned for the Earth and are doing OK!
70 - 79 points: You need to make plans and try harder.
Below 69 points: STOP NOW and Take Action in your family to prevent pollution!

A Closer Look At Glass

Glass is an ideal material for reuse. Each person in the United States uses almost 400 bottles and jars each year, and none of these belong in our landfills and incinerators. Because glass takes so long to decompose, the bottle you throw away today might still be littering the landscape or taking up space in the landfill in the year 3000.

At home, some of these glass bottles and jars can be safely washed and rinsed and reused as food containers.

Although glass bottles are designed to handle up to 30 round trips from manufacturer to consumer, glass production for beverage containers is decreasing as plastics become more popular. Fewer refillable glass bottles are available.

The next best thing to reusing glass is recycling it.

According to the Glass Packaging Institute, the United States recycled 33 percent of its glass bottles and jars in 1993, up from 29 percent in 1990.

Glass can be collected, crushed into cullet, melted and used again and again. **Glass is 100 percent recyclable.** Glass doesn't degrade with recycling. It can last for hundreds, perhaps thousands of years.

Although the raw materials from which glass is made are plentiful, their collection and transformation into glass require a large amount of energy. It takes about 7,600 Btus of energy to produce just one pound of glass. Along with the production of one ton of glass come nearly 400 pounds of mining wastes and 28 pounds of air pollution.

To make glass using recycled glass, the used glass or crushed cullet is mixed with the raw materials of sand, soda ash and limestone. The mixture is heated in a furnace at temperatures of up to 2,800° F. Using cullet saves energy because it melts at lower temperatures than that required to produce glass from raw materials. For each 10 percent of cullet used, the furnace can be lowered 10° F.

Glass can be made from as much as 93 percent recycled glass. Using one ton of recycled glass saves 1.2 tons of raw materials. According to one estimate, by using 50 percent recycled glass in manufacturing new glass, water consumption can be cut in half, mining wastes cut by 70 percent and air emissions reduced by 14 percent.

To be recycled, glass must be separated by color – clear, amber and green. This ensures color consistency of the new container being made.

In preparing glass for recycling, it is important to remove the lid and rinse out the container. Labels do not need to be removed since they are burned off in processing. Separate glass by color. You'll want to find out which colors are recycled in your area.

Recipe for Making Glass

To make just one ton of glass:
1,330 pounds of sand
433 pounds of soda ash
433 pounds of limestone
151 pounds of feldspar
15.2 million Btus of energy

Major deposits of white sand suitable for making glass are found in Illinois, New Jersey, the Alleghenies and the Mississippi Valley.

Most soda ash comes from Wyoming, and 65 percent of the feldspar in the U.S. comes from California and North Carolina.

Different colored glass is produced by adding small amounts of other substances such as iron, copper and cobalt. Green glass is made by adding iron.

To save these resources, glass can be made from as much as 93 percent recycled glass.

In recycling glass, it is critical not to recycle Pyrex glass, ceramics, plates or drinking glasses, light bulbs or mirrors. A single piece of these materials can contaminant a large load of recyclable glass.

Other Uses For Recycled Glass Emerging

According to the Glass Packaging Institute, a growing number of secondary markets are emerging for mixed-color or off-spec cullet. This cullet can be used for a replacement for gravel and crushed stone in road base construction, pipe backfill and storm drains; and as an ingredient in a form of asphalt, known as "glasphalt." Mixed cullet is also used to a limited degree in the fiberglass insulation industry; in the production of reflective beads and reflective paint; and as an abrasive in sand-blasting. Today, more than 95 percent of the U.S. residential curbside collection programs include glass. Obstacles to glass recycling are that it can break during collection and transport (broken glass is hard to reuse), it must be sorted by color, and even small amounts of unsuitable glass can contaminant an entire load.

More About Glass

The energy saved from recycling one glass bottle will light a 100-watt bulb for four hours.

Every ton of crushed waste glass saves the equivalent of about 30 gallons of oil.

Glass Recycling in Europe - 1991

Country	Collected volumes (tons)	% Recycled
Austria	223,000	60%
Belgium	60,000	55%
Denmark	15,000	35%
Finland	987,000	31%
France	2,295,000	41%
Germany	26,000	63%
Greece	16,000	22%
Ireland	763,000	23%
Italy	360,000	53%
Netherlands	10,000	70%
Norway	50,000	22%
Portugal	310,000	30%
Spain	57,000	27%
Sweden	199,000	44%
Switzerland	54,000	71%
Turkey	385,000	28%
United Kingdom		21%
Total	5,966,000	46.3%

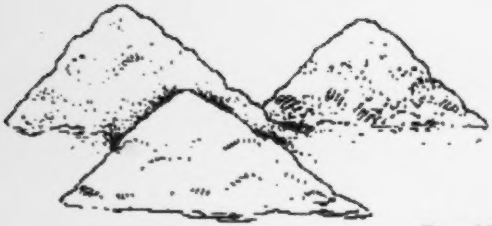
Note: According to the Glass Packaging Institute, the United States recycled 33 percent of its glass bottles and jars in 1993, up from 29 percent in 1990.

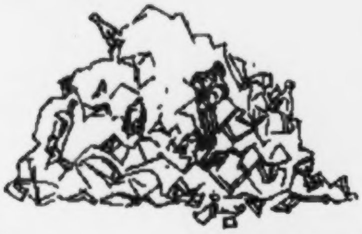
source: Warmer Information Sheet

New Glass Technologies

According to a newsletter by the Warmer Campaign, funded by the World Resources Foundation, techniques have been pioneered in the United States to cover clear glass with colored coatings which, when the glass is being recycled, simply dissolve. If all glass were manufactured clear and then colored in this way, instead of the integrated green and amber coloring at present, there would be no limit to the amount of cullet that could be reused in the production of new containers. Best of all, there would be no need to sort glass for recycling.

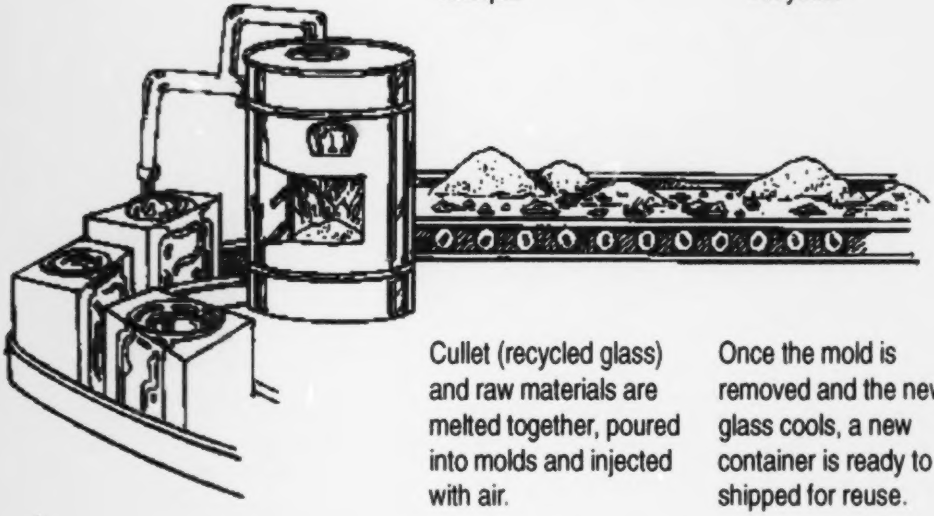
Glass Manufacturing





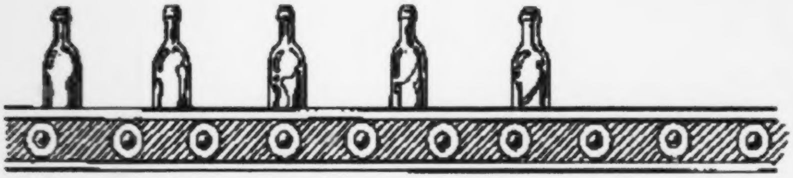
Raw Materials:
sand, soda ash, limestone, feldspar

Recycled Materials:
cullet or glass to be recycled



Cullet (recycled glass) and raw materials are melted together, poured into molds and injected with air.

Once the mold is removed and the new glass cools, a new container is ready to be shipped for reuse.



Take A Closer Look At Paper

Since 37.6 percent of everything we throw away is paper, recovering paper helps ease the burden on our overcrowded landfills.

Today most paper comes from trees. However, before 1850, paper in the United States was made from recycled fibers from rags and waste paper. From 1690 when the first paper mill was built near Philadelphia to 1850 when wood replaced rags and waste, paper mills were large recyclers.

After the switch from rags to wood, paper mills continued recycling old waste paper as part of the manufacturing process. In 1916, the United States produced 15,000 tons of paper a day and used 5,000 tons of waste paper in the process, a 33 percent recycling rate.

Today, the United States is the largest producer and consumer of paper and paper products in the world.

Wood that is unsuitable for use as lumber and lumber mill wastes are used to make paper. According to some experts it takes the equivalent of 17 trees to make one ton of paper, however the Paper Information Center of the American Paper Institute says that it is inaccurate to suggest that it takes a specific number of trees because trees come in a variety of sizes. The Center also says that, in large measure, trees harvested for paper were planted for that purpose. They also note that U.S. papermakers obtain over half their raw material from waste products _ waste wood, such as chips and sawdust, and recovered paper.

Many large pine forests in the Southeast are grown and harvested for paper. Paper mills are generally located near the source of trees to save transportation costs. About 35 percent of the world's annual commercial wood harvest is used to produce paper, and this share is expected to grow to 50 percent by the year 2000.

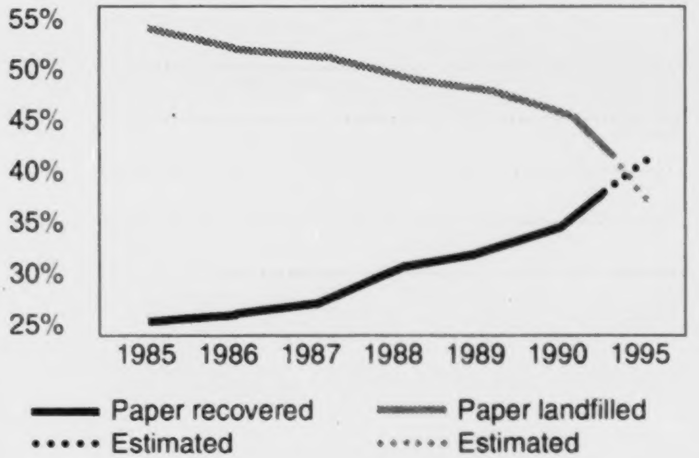
Although wood is a renewable resource, the experts do not agree on our preservation rates. Some say we are presently using more of our forest resources than we are replacing, while the American Paper Institute says the U.S. has more trees today than it did 70 years ago.

According to the U.S. Forest Service, federal tree-cutting is nearly three times greater than federal tree-planting. In the South, however, in 1989 the government cut 132,638 acres of timber and planted 127,913 acres.

In addition to depleting natural resources, manufacturing paper uses energy and creates pollution. And that doesn't include the waste that comes from the disposal of the paper itself.

Paper Recovered to Exceed Paper Landfilled

source: American Paper Institute and Franklin Associates



Why Recycle Paper?

Recycling helps extend the life of our landfills. Nearly a third of our waste stream by weight and over half by volume is paper. If we recycled half of the paper used in the world today we would meet almost 75 percent of the demand for new paper and leave nearly 10 million acres of forest standing.

Today, nearly four times more paper is being diverted from the waste stream than all other recyclable materials combined. But the best news about paper recycling is that it is growing by leaps and bounds. Two years ago, America's paper companies set an ambitious goal: By the end of 1995, recover – for domestic recycling and export – 40 percent of all the paper Americans use. The industry is pleased to report that this goal was achieved two years sooner than expected. The new paper recycling goal is 50 percent.

International Paper Recycling Rates

Japan	**45%**
Spain	**40%**
Brazil	**39%**
South Korea	**37%**
Hungary	**37%**
West Germany	**35%**
Sweden	**34%**

source: A-Way With Waste, Earth Paper Company, 1986

Note: the paper recycling rate in the U.S. was about 40% in 1994.

In 1993, more than half the newspapers published were recovered – up from a third four years earlier. About 60 percent of corrugated boxes are recycled.

A campaign is underway by the National Office of Paper Recycling to increase office paper recycling. About half of all paper is generated in the workplace and currently only about 15 percent of it is recycled. The campaign also emphasizes *closing the recycling loop* by collecting paper for recycling and purchasing recycled paper.

Executive Order Says Purchase Recycled Paper

In 1993, one of the biggest stories in recycling came from Washington, D.C. where President Clinton signed an Executive Order mandating the purchase of paper with recycled content. The Order specifies for all federal paper purchasing a minimum of 20 percent postconsumer content by the end of 1994 and 30 percent by the end of 1998.

The federal government uses 300,000 tons of printing and writing paper a year. The increased purchasing of recycled content is significant, but the long-term impact is expected to be greater from state and local procurement programs following the federal lead.

In South Carolina, the Solid Waste Policy and Management Act of 1991, describes a preference in State procurement policies for products with recycled content.

How Paper Recycling Works

At recycling centers, paper is sorted and baled for shipping and is transported to one of more than 600 paper mills in the United States. More than 75 percent of our paper mills recycle some recovered paper, 200 mills depend on it entirely. The industry is spending billions of dollars to expand recycling capabilities.

According to Cynthia Pollack-Shea, *Realizing Recycling's Potential*, building a mill designed to use waste paper instead of virgin pulp is estimated to be 50 to 80 percent cheaper.

In 1993, the pulp and paper industry continued to build large scale facilities for deinking ledger and newsprint and processing old corrugated. Seventeen new or expanded deinking facilities were completed.

U.S. paper companies are expected to obtain nearly one-third of their fiber from recovered paper by mid-1990s. Add to that the 25 percent from wood wastes and forest residues and the industry will then rely on recovered materials for more than 56 percent of its fiber.

There are about 1,400 waste paper dealers located throughout the U.S. According to the South Carolina Recycling Markets list, 38 companies in our state handle waste paper from cardboard to computer paper to newspaper to magazines.

Paper recycling is not without its environmental concerns though, as it requires large amounts of water that must be treated to remove chemicals.

However, according to the Institute of Scrap Recycling, there are environmental benefits to paper recycling beyond the obvious benefits of keeping paper out of the waste stream and preserving our forests. Making new products from scrap results in significant energy savings and does use less water than making paper from virgin materials.

Every ton of recycled paper produced requires 7,000 fewer gallons of water to make than virgin paper. Each ton requires approximately 4,100 kilowatthours less energy as well.

According to the Institute, making paper from recycled materials results in 74 percent less air pollution and 35 percent less water pollution.

Waste paper is usually recycled into a lower grade product than the original, as wood fibers break up and deteriorate. Unlike aluminum and glass, a given quantity of wood fiber cannot be recycled perpetually.

One way to keep the quality of recycled paper high is through sorting. High-grade computer printout can be recycled back into computer printout paper, newsprint can become newsprint again. When fibers are mixed they turn out lower grades of paper.

Magazines and slick papers were once though to be difficult to recycle because of the heavy clay coating used to make the paper hold the inks. Some new techniques suggest that the clay coating helps absorb the toxic inks from the recycling water.

U.S. EPA Recommended Minimum Recycled Content Standards for Paper and Paper Products

Fine Paper	% Waste Paper
•Offset printing	50
•Mimeo and Duplicator paper	50
•Stationery	50
•Office paper	50
•Copier paper	50
•Envelopes	50
•Computer paper	50
•Book paper	50
	% Postconsumer Recovered Material
Newsprint	40
Tissue and Towel	
•Toilet tissue	20
•Paper towels	40
•Paper napkins	30
•Facial tissue	5
Boxes	
•Corrugated boxes	35
•Fiber boxes	35
•Brown paper bags	5
Paperboard	
•Recycled paperboard products including folding cartons	80
•Pad backing	90

In the future more and more magazines may be included in recycling.

Recycled fibers are often made into newsprint and writing paper; roofing felt, insulation board, fiberboard, other construction materials; fruit trays, flower pots, egg cartons and other products made from molded paper pulp; kraft paper, tissue, corrugated cardboard and cardboard boxes.

A large quantity of waste paper is also exported to other countries.

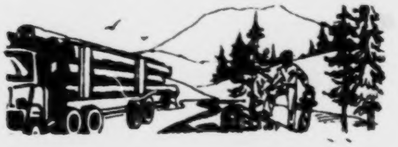
According to the Institute of Scrap Recycling Industries, Inc., leading foreign purchasers of scrap paper include Korea, Mexico, Taiwan, Japan, Canada, Italy, Spain, and Venezuela.

Before Recycling Paper

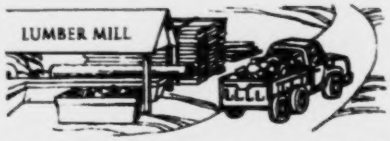
There are many ways to reduce the amount of paper we use so that we will have less to deal with in the waste stream. In the classroom, always use both sides of the sheet and place scrap paper in a bin for reuse in art projects and as note paper. Many schools use large quantities of computer paper that can be reused for art and other projects by younger students.

Paper Manufacturing

1

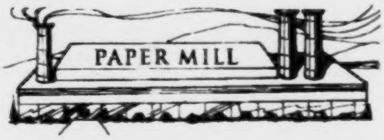


2



Wood wastes from lumber mills are used to make paper.

3

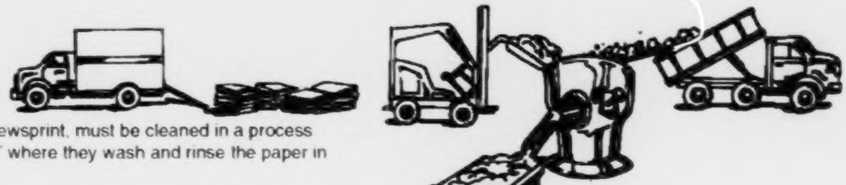


Paper mills turn the wood into paper ready for you to use.

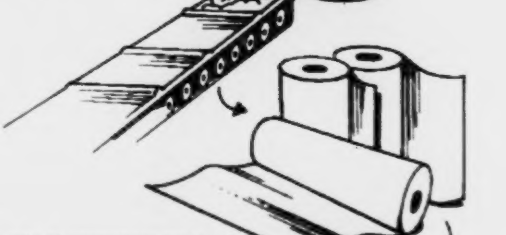
4

Once paper is used, it should be recycled, not thrown away.

5



Old paper, like newsprint, must be cleaned in a process called "de-inking" where they wash and rinse the paper in large vats.



Sometimes newsprint and wood wastes are combined, mixed into pulp and poured onto large rollers. Other times, mostly used paper is processed again.

6

The rolls of newspaper are used again to make newspapers, drawing paper, computer paper, and many other kinds of paper.

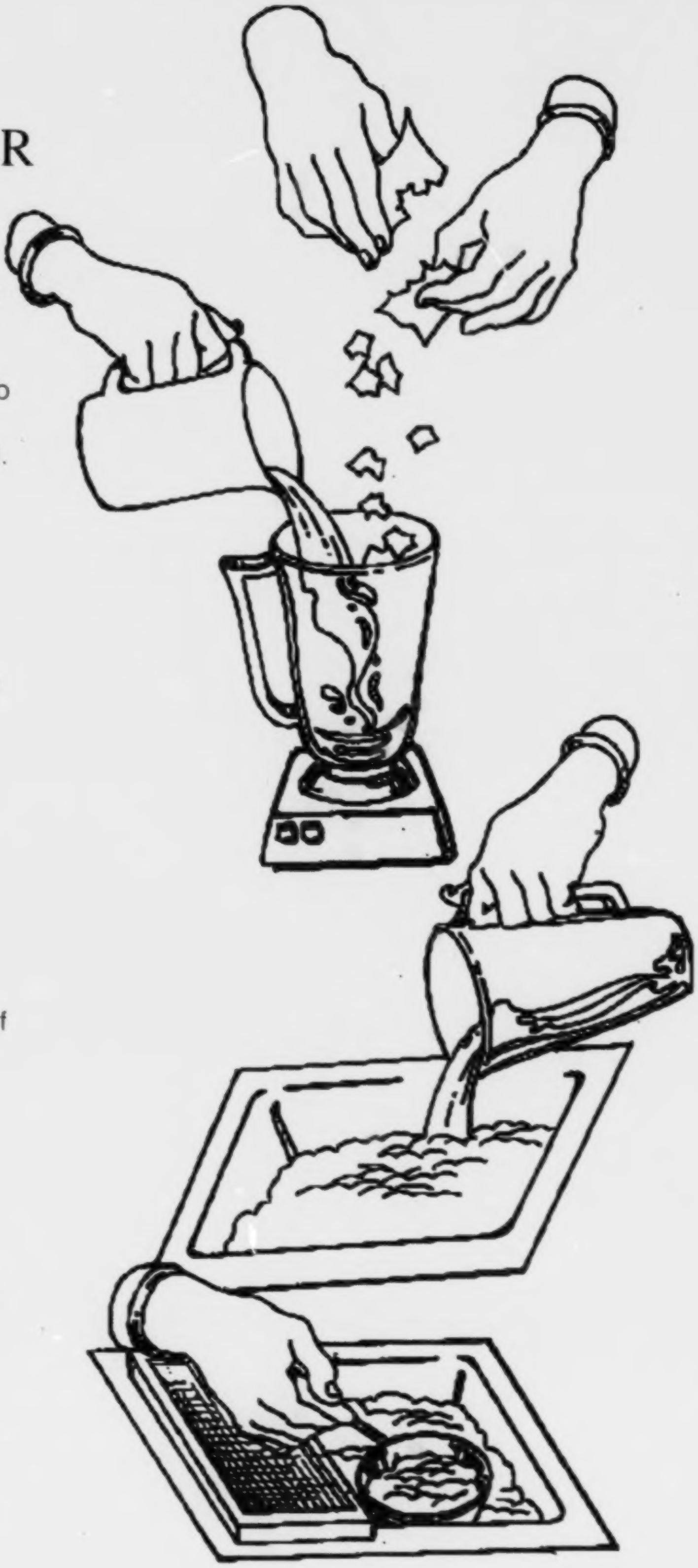
Paper Manufacturing

To make one ton of paper it takes:

- 3,688 pounds of wood
- 216 pounds of lime
- 360 pounds of salt cake
- 76 pounds of soda ash
- 24,000 gallons of water
- 28 million Btus of energy

In addition, 84 pounds of air pollutants, 36 pounds of water pollutants, and 176 pounds of solid waste are created in the process.

MAKING PAPER



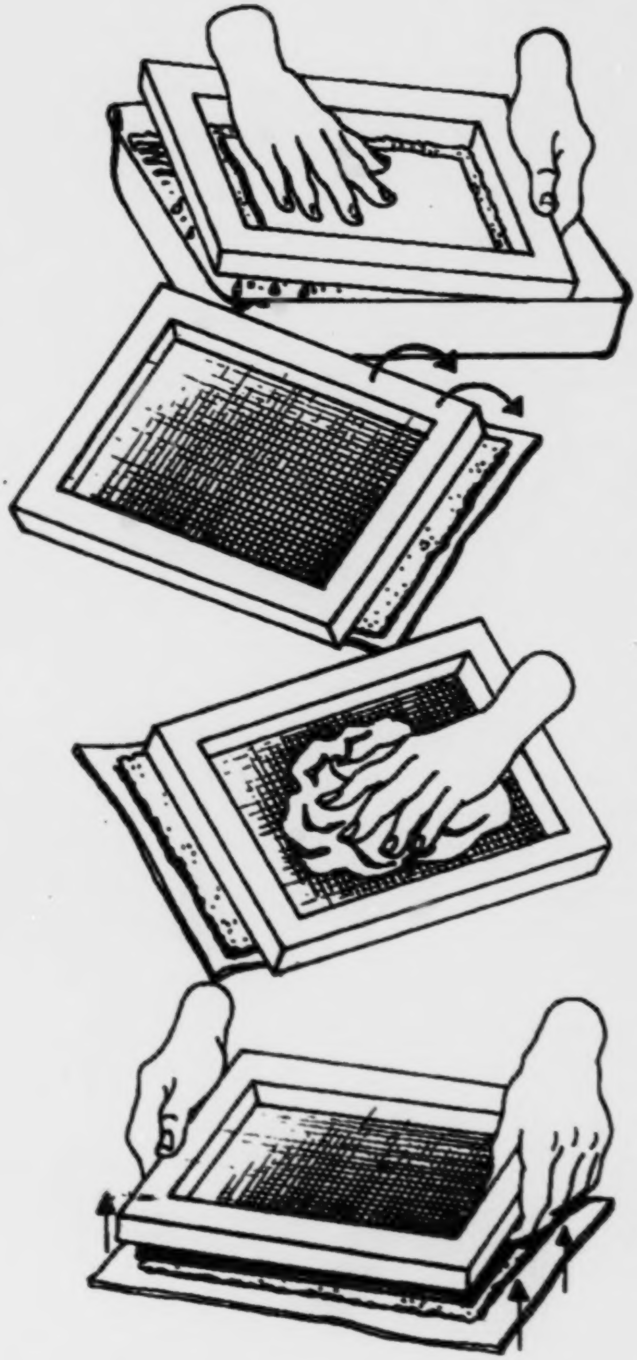
1. Tear sheets of used paper (one different type for each group of students) into small strips about one-inch square. Loosely pack into blender until 1/3 to 1/2 full. Add warm water until blender is 2/3 full.

2. Blend, with lid on, until the paper looks like oatmeal – 5 to 10 seconds.

3. Empty the blender into a pan and add about 1/2 inch (1.3 cm) of water for every blender of pulp, adding more or less depending upon the thickness of paper desired.

4. Scoop the pulp mixture evenly onto the screen with a cup – hold the frame over half the pan. Let the pulp drain.

OPTION: You may dip the screen under the pulp and pull it up so that the pulp spreads out evenly on the screen. Don't forget to let the excess water drain into the pan.



5. Place a piece of blotter paper over the wet pulp paper formed on the screen.

6. Flip the screen over so the pulp paper is between the blotter and the screen with the screen on top.

7. Soak up extra water with a sponge. This water can be squeezed out and collected along with the water in the pan.

8. Lift off the screen and place the new paper in a safe place to dry. Drying takes one or two days. Exchange blotter and dry paper towels every few hours if you want the paper to dry more quickly, or you may iron the paper to speed up the process. If you choose to iron your paper, place a sheet of paper between the new paper and the iron.

A Closer Look At Plastic

Today most plastics are made from natural gas and crude oil – valuable nonrenewable resources.

Nationally, plastics make up about 9 percent of our solid waste stream by weight and 20 percent by volume, a share that has steadily increased since plastics were introduced to the consumer market 30 years ago.

In South Carolina, plastics make up about 9 percent, by weight, of our municipal solid waste stream, according to the South Carolina Solid Waste Management Annual Report for 1993.

Today the largest use of plastics is packaging.

Nationally, plastic packaging comprises 25 percent of the plastics produced each year, and is over 50 percent of the plastics found in municipal waste.

Plastics popularity has increased for several reasons: plastic is durable, lightweight, waterproof, adds to consumer convenience, and is relatively inexpensive to produce.

Unfortunately some of the same characteristics that make plastic an attractive packaging material also make it a special waste problem. Though lightweight, plastic is bulky and difficult to compact for burial in landfills. Plastic will not biodegrade in landfills. Even photodegradable plastics will not disappear in today's modern landfill because there is no light.

The Plastic Litter Problem

All litter is unsightly, and whether it's paper or plastic, litter is preventable. Plastic litter has gained special attention though because it is responsible for particular problems in our oceans and on our beaches. Thousands of fish, sea mammals and birds die because they eat and become entangled in discarded fishnets, six-pack rings, plastic bags, and other packaging materials.

During the 1970s and 1980s biologists began paying attention to reports about animals ingesting plastics. As many as 15 percent of the world's 280 species of sea birds are known to have ingested plastic, according to an article in Natural History, *Plastics at Sea* by D.H.S. Wehle and Felicia C. Coleman. Sea birds choose a wide variety of plastic objects: raw particles, fragments of processed products, bottle caps, polyethylene bags, and even plastic toys.

Marine turtles consistently select plastic bags to eat thinking that they are jellyfish. Plastic bags have been found in the stomachs of four of the seven species of marine turtles: Leatherbacks from New Jersey, New York, French Guiana, South Africa and the coast of France; Hawksbills on the coast of Costa Rica; Greens in the South China Sea and in Japanese, Australian and Central American coastal waters; and Olive Ridleys off Mexico.

Since this time, international conventions have been passed that help protect our oceans from pollution. These include MARPOL, the Protocol of 1978 to prevent pollution by ships at sea, and the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter.

A Source Reduction Strategy

According to the Society of the Plastics Industry, plastics contribute to source reduction by reducing packaging waste volume. Plastics are lightweight and strong, meaning it often takes less plastic to make certain items compared to other materials. According to a study by Germany's Society for Research into the Packaging Market, if there were no plastics:

- energy used to produce packaging would double
- packaging weight would increase four-fold
- the cost of packaging would double
- the volume of packaging waste would increase by 250 percent.

Plastic & Progress: Less is More

Plastics research has found ways to reduce the volume of plastic used to do certain jobs. This helps conserve resources and reduces the volume of trash that can result. For example, plastic grocery sacks were 2.3 mils (thousandths of an inch) thick in 1976 and were down to 1.75 mils by 1984. In 1989, new technology gave the same strength and durability in a bag only 0.7 mils thick.

Today's milk jug, made of HDPE plastic weighs only 60 grams, the same jug weighed 95 grams – more than 50 percent more – in the early 1970's.

Plastic Snack Bags are Munch Better, or are They?

Snack bags made of plastic have changed significantly in the last decade. Snack bags, such as potato chip bags, now in use are no more than 2/1000 of an inch thick and keep the product fresher longer than the one-third-thicker bags used in the 1980s. However, in making the bags thinner and stronger, engineers have created a mixed plastic package that cannot be recycled at this time.

Today's multi-layer, composite plastic snack bag contains nine layers including a layer of copolymer PP/PE (polypropylene and polyethylene); a layer of polypropylene which acts as a moisture barrier, provides stiffness, and is puncture resistant; and interior layers that include an adhesive modified PP/PE for ink adhesion, inks for high-quality graphics, polyethylene, and aluminum metalization as a oxygen and moisture barrier. The inside layer is a sealant type PP/PE copolymer for sealing, easy opening, and tamper evidence. This construction, although complex, has advantages in materials and filling costs that lower the final product cost to the consumer.

Next time you have the urge to snack, take a look at the bag. It's munch more than it appears.

Why Do We Need Different Kinds of Plastics?

According to information from the Society of the Plastics Industry, all plastics are related, but each resin has attributes that make it best suited to specific applications. Copper, iron, and aluminum are all metals, but you wouldn't make a car out of iron or a soda can out of copper. In the same way, one kind of plastic would not be suited for all applications. For example, PET is used in soda bottles because it holds in carbonation, polypropylene can be "hot-filled" and HDPE and PVC allow a handle to be put on the container.

How Much Plastic is Recycled?

In 1991, post-consumer plastics recycling (the plastics that you purchase, use, and recycle) increased 44 percent over 1990. However, the U.S. EPA estimates that only 2.2 percent of *all* plastics are being recovered for recycling.

When you break out the figures for plastic packaging recycling the numbers improve. The American Plastics Council reports that 6.5 percent of plastic packaging was recycled in 1992 and that 41 percent of plastic soft drink bottles and 24 percent of plastic milk jugs were recycled in 1993.

Consumer awareness about plastics recycling and a concentration on recycling two popular forms of plastic: PET (primarily from soft drink bottles) and HDPE (from milk jugs, juice and water bottles) has increased plastics recycling in South Carolina as well. These items are recycled throughout the state and are accepted by most collection programs.

Besides more plastic collected through community collection programs, more than 16,000 grocery stores now collect plastic grocery bags for recycling.

IF YOU KNOW THE CODE ... You can tell what resin the product is made from.

To make recycling easier, plastics manufacturers are now using a **standard coding system** on single use plastic containers to identify the **resin** type (the artificial substance similar to natural resin from trees.) Since plastic recycling opportunities are different throughout the country, consumers should find out which types of plastics are recycled in their communities and make purchases and recycle accordingly. The plastic type used for many typical products is changing as more manufacturers move to packaging using Number 1, PET and Number 2 HDPE. These two plastic types are the most recycled in South Carolina.

Plastic Container Code System For Plastic Containers

Symbol/Code	Material	Typical Products	Can Be Recycled Into
1 PET or PETE	Polyethylene terephthalate (PET or PETE)	soft drink bottles, peanut butter jars. 25% of all plastic bottles.	carpets, surfboards, sailboat hulls, strapping
2 HDPE	High-density polyethylene	milk, water & juice jugs, detergent bottles. More than 50% of all bottles.	trash cans, base caps for soda bottles, detergent bottles, drain pipes
3 V	Vinyl/polyvinyl chloride (PVC)	cooking oil bottles, some shampoo bottles. Less than 6% of bottles.	fencing, handrails, house siding
4 LDPE	Low-density polyethylene	dry cleaning, bread & trash bags, squeeze bottles. 10% of bottles.	grocery bags, garbage can liners
5 PP	Polypropylene	yogurt cups, margarine tubs, straws. 5% to 10% of bottles.	birdfeeders, pails, water-meter boxes, car-battery cases
6 PS	Polystyrene	egg cartons, meat trays, coffee cups, carryout containers, video tapes.	pencil holders, tape dispensers, license-plate frames, trays
7 Other	All other resins and layered multi-material	microwavable serving ware.	benches, picnic tables, roadside posts, marine pilings

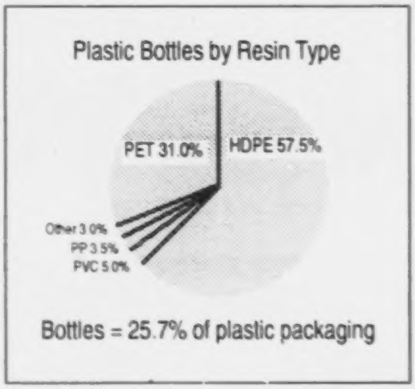
There are hundreds of different kinds of plastics, more than 46 of which are in common use. Each type has a different chemical composition and is carefully engineered for a specific purpose. Layers of different plastics can be used in just one container, each adding a special quality to the design. The **National Voluntary Plastic Container Coding System** identifies plastics for recycling using a recycling symbol with the plastics coding number in the center. Note: this symbol does not mean that the plastic can be recycled in your area, it simply refers to the resins type of the plastic. In South Carolina, plastics coding is mandatory.

What Happens to Plastic Collected for Recycling?

Plastics from community collection programs are sorted by their code (many programs only accept PET and HDPE, or plastic soda bottles and milk jugs) and are then taken to reclamation centers where sorted plastics are chopped, washed and converted into flakes or pellets. These flakes or pellets are then used to manufacture a new product.

Originally, recycled plastic was limited to making park benches and landscaping timbers. These items are still made today from recycled mixed plastics, but today's more sophisticated plastics sorting and recycling makes a variety of products.

- **Recycled PET** is used in making soft drink bottles, deli and bakery trays, carpets, fiberfill, tennis ball containers and paint brush bristles.
- **Recycled HDPE** can become bottles for laundry products, recycling bins, agricultural pipe, bags, soft drink bottle base cups or motor oil bottles.
- **Recycled vinyl** becomes pipe, fencing and non-food bottles.
- **Recycled LDPE** is used to manufacture new bags and films.
- **Recycled PP** is used in auto parts, carpets and industrial fibers.
- **Recycled PS** is used in a wide range of products including office accessories, cafeteria trays, toys, video cassettes and insulation board.



Proper Sorting is Key to Plastics Recycling

The plastics coding system is critical to recycling because several types of plastic can look the same. For example, a bottle made from clear, number 3 polyvinyl chloride (PVC) may look identical to bottles made from clear, number 1 polyethylene terephthalate (PET), or like packages made from clear, number 6 polystyrene (PS). A recent study shows that even small amounts of the wrong type of plastic can contaminate and ruin an entire load of recycled plastic. If even one number 6, PVC, bottle slips through a sorting system into a container of 1,000 pounds of PET plastic flaked for processing, the entire load can be ruined.

This is why many communities choose to recycle only certain containers such as milk jugs (number 2 HDPE) and soda bottles (number 1 PET). This avoids any misidentification.

PET: A Recycling Success Story

The PET plastic bottle was patented in 1973 and in 1978 the first PET soft drink container appeared on the market.

Today, PET plastic is identified with the coding "1" and PETE. In 1991, programs to recycle PET plastic containers increased dramatically.

According to the National Association for Plastic Container Recovery (NAPCOR), among curbside and drop-off programs, 89 percent collect PET plastic.

Today PET plastic is second only to aluminum in recycling market value.

Plans to use recycled PET plastic in new soft drink bottles were introduced by the Coca-Cola Company and PepsiCo Inc. in 1991. Closed-loop or bottle -to-bottle recycling is expected to have a major impact on market growth. The new recycling processes are called glycolisis and methanolysis. Post-consumer plastics are literally broken down to their building blocks and repolymerized, or rebuilt, ensuring the purity of the recycled resin.

From Soda Bottles to Apparel

One of the largest recyclers of plastics in the United States is Wellman, Inc., located in Johnsonville, South Carolina. Wellman uses recycled plastic to create fibers used in a variety of products, such as carpeting and filling for pillows and clothes. Hoechst Celanese in Spartanburg is opening a $6 million recycling plant to process plastics. Company representatives estimate that about 150 million PET and HDPE bottles and containers will be processed annually.

Wellman recently announced a process that allows them to refine and purify plastic bottles, creating a new fiber, a recycled polyester – Fortrel EcoSpun, the Renewable Resource™ that is suitable for making apparel. According to Scientific Certification Systems, an independent company that evaluates environmental claims, Wellman has earned the right to display the Scientific Certification Systems green cross certification for the product.

The environmental merits of the fiber include:

- For every pound of 100 percent Fortrel EcoSpun, approximately ten bottles are kept out of landfills.
- 4.8 billion bottles were kept out of the landfills in just two years of recycling by Wellman, saving 1.3 million barrels of oil.

Johnson Controls Launches New Technology

In 1994, Johnson Controls, Inc., the largest manufacturer of soft drink bottles in North America, announced a new process that allows old plastic soft drink bottles to be turned into new ones. U.S. Food and Drug Administration (FDA) cleared the way for Johnson Controls' Supercycle ™ 100 percent post-consumer recycled PET material to be used in all types of beverage and food containers. The process incorporates high-intensity washing, high temperature (500 degrees F) and other advanced cleaning procedures to meet strict FDA standards. The process is reported to be less expensive that depolymerization or multi-layer processes.

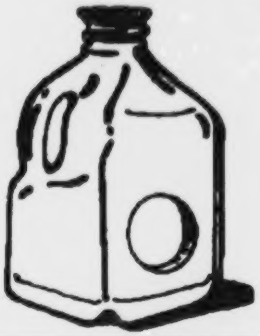
How Plastic is Made

Plastics are made by linking together small single chemical units called monomers in repetition to build one large molecule called a polymer. The plastic monomers are made from hydrogen and carbon elements "hydrocarbons," derived from petroleum and natural gas, in combination with small amounts of oxygen, nitrogen and other organic compounds. When rearranged chemically, they produce a solid resin. The resins are used to make hundreds of different plastics, all of which fall into three basic categories.

Thermoset plastics, which can be heated and molded only once, are used in automobile bodies, toys, computer casings and to make nonstick cookware. Thermoset plastics are difficult to recycle.

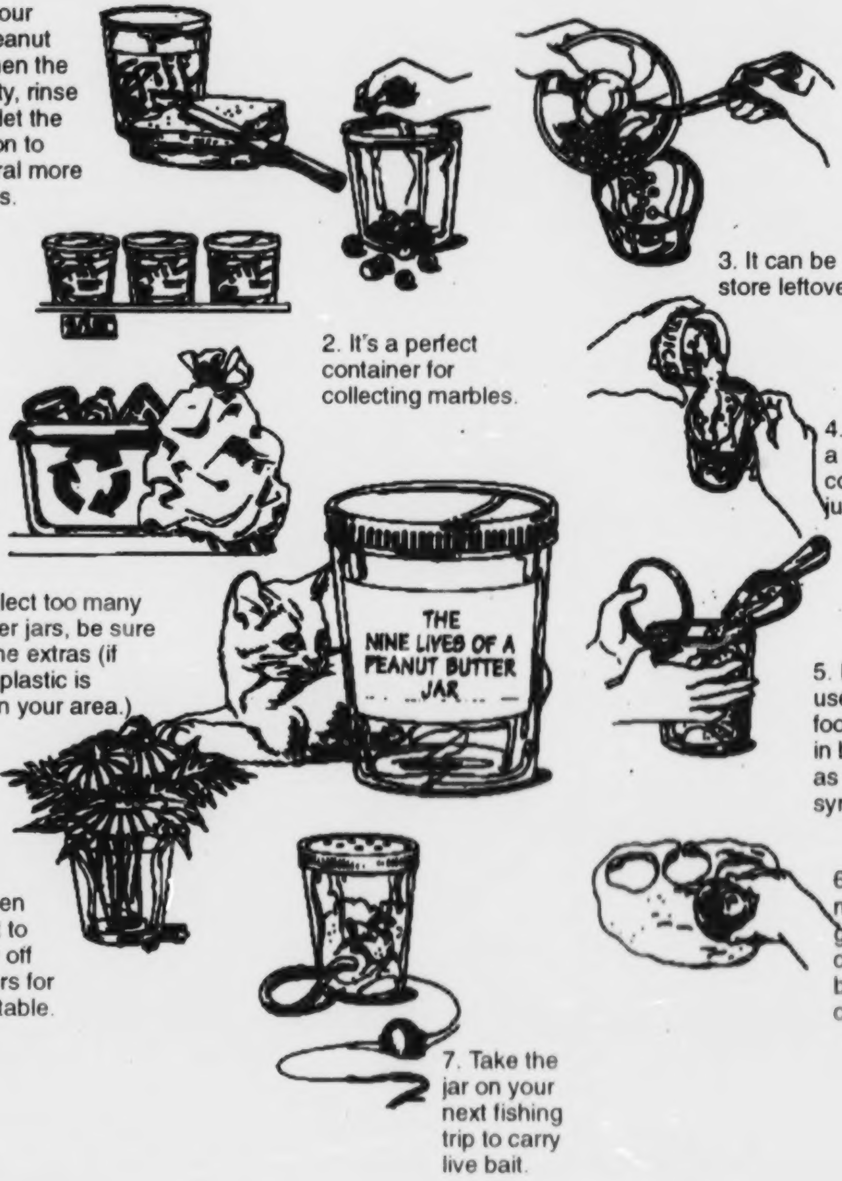
Thermoplastics, the kind of plastic used in milk jugs, are recyclable. They may be remolded several times. Thermoplastics are widely used in packaging. Some reuses for thermoplastics are boat docks, park benches, pallets and filler for ski jackets.

The newest type of plastics are degradables. Some degradables can be broken down by light, others by salt water and others by biodegradation. Degradable plastics are not recyclable and have yet to prove themselves as a major solution to the plastic waste stream. Because there is little light or air inside landfills, degradable plastics do not breakdown in landfills.



The Nine Lives of a Peanut Butter Jar

The life of a peanut butter jar begins when you buy it filled with your favorite brand. When emptied and cleaned, your family can use it in many ways.


THE NINE LIVES OF A PEANUT BUTTER JAR

1. Enjoy your favorite peanut butter. When the jar is empty, rinse it out and let the jar move on to lead several more useful lives.

2. It's a perfect container for collecting marbles.

3. It can be used to store leftovers.

4. And to mix a batch of concentrated juice.

5. It can be used to store foods bought in bulk such as maple syrup.

6. The jar makes a great cookie or biscuit cutter.

7. Take the jar on your next fishing trip to carry live bait.

8. Then use it to show off flowers for your table.

9. If you collect too many peanut butter jars, be sure to recycle the extras (if this type of plastic is recyclable in your area.)

A Closer Look At Metals

Industry has recycled metals for many years. Although some consumers may think of metals recycling as new, the first two major aluminum recycling plants opened in Chicago and Cleveland in 1904. Because of the expense of mining, business has used recycling of metals as a way to keep costs down.

Today, consumers are eager to recycle metals for several reasons: to prevent depletion of valuable resources, to prevent the pollution that mining new metals can cause, to reduce the amount of garbage they throw away, and to make money.

Recycling Aluminum

Several characteristics make aluminum a valuable resource. Lightweight, versatile and strong while flexible, aluminum is used for packaging, building, automobile and aircraft construction.

To make aluminum more rigid, it can be alloyed with small amounts of other metals. Because of its love for oxygen, aluminum resists corrosion by forming a protective coating of aluminum oxide when exposed to air. It is a good conductor and insulator.

Aluminum makes up about 8 percent of the Earth's crust, and it is the third most common element after oxygen and silicon. Aluminum was discovered in the 1820s. At that time it was worth $1,200 a kilogram, more than gold.

Widely dispersed through most clays and rocks, it's commonly found as hydrated aluminum oxide. It is never found naturally in its metallic state. The greatest concentrations of aluminum are found in bauxite ore, where it is found as alumina in combination with oxide, titania, and silica.

The Recipe for One Ton of Aluminum

These resources are used to produce one ton of aluminum:

- 8,766 pounds of bauxite
- 1,020 pounds of petroleum coke
- 966 pounds of soda ash
- 327 pounds of pitch
- 238 pounds of lime
- 197 million Btus of energy.

The wastes created include:

- 3,290 pounds of red mud (iron, titanium and silica)
- 2,900 pounds of carbon dioxide
- 81 pounds of air pollutants
- 789 pounds of solid wastes.

Recycling saves 95 percent of the energy required to produce aluminum from raw mterials.

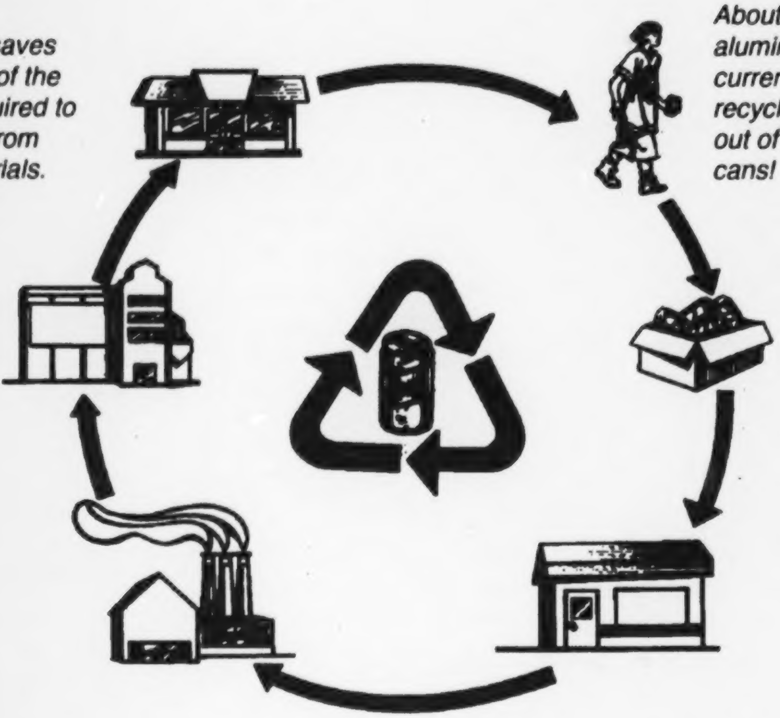
Most of the world's bauxite reserves are located in the subtropics. Substantial bauxite deposits are located in Jamaica, Australia, Surinam, countries of the former Soviet Union, Guinea, France, Yugoslavia, Greece, and Hungary. The limited United States reserves are located in Arkansas, Georgia and Alabama.

The U.S. imports 90 percent of its bauxite.

Aluminum in Transportation

The amount of aluminum used in cars made in the United States increased from 78 pounds per car in 1972 to more than 200 pounds per car today. This is because aluminum construction helps make cars that are lighter and use less gas.

As many as 90 percent of the truck trailers used in this country also have aluminum bodies. Aluminum is the primary aircraft material, making up about 80 percent of the structural weight of jets.



Recycling Aluminum saves 95 percent of the energy required to produce it from virgin materials.

About 68 percent of aluminum cans are currently being recycled – that's four out of every six cans!

From Ore to Useful Metal

Surface mining of bauxite produces solid waste, air pollution and hazardous waste. Once taken out of the ground it requires further refinement. The metal is then poured into bars and transferred to manufacturing plants which re-melt and form the aluminum into various items.

Fifty-five percent of the world's aluminum is produced in the United States, the former Soviet Union, Canada, Japan and West Germany.

While the supply of aluminum resources is plentiful, mining, refining and manufacturing products from aluminum uses energy and creates waste and pollution. This is why aluminum should never be thrown away.

The first aluminum beverage can appeared in 1963 and the first consumer can recycling center was opened in 1968.

Why Recycle Aluminum?

Recycling a single aluminum can saves as much energy as a can half-filled with gasoline. In addition, recycling aluminum eliminates 95 percent of the air pollution.

All aluminum products, including aluminum foil, cans and foil containers can be recycled.

According to the Alcoa Aluminum Company, the turn around time for an aluminum can is only six weeks from manufacturing the can, to filling it, delivering it to the store, being purchased, emptied, recycled by the consumer, shipped to a processing plant, made into a sheet of aluminum, made into an aluminum can, shipped to the filler, filled, and shipped to the store.

When we recycle aluminum, it goes to scrap dealers that sell it to smelters. The smelters chemically analyze the aluminum and shred and decontaminate it. Steel is removed from shredded aluminum as it passes over magnetized conveyer belts. Contamination of more than 1 percent non-aluminum metals makes the aluminum unusable in a smelter.

Once shredded and decontaminated, the aluminum scrap is melted for 18 hours. The molten metal is then poured into forms and allowed to cool. The resulting ingots are transported to manufacturing plants, re-melted and formed into new products.

Facts About Aluminum ...

Today, enough aluminum cans are recycled to rebuild the entire U.S. commercial airline fleet every 10 weeks.

Each person in the United States uses an average of two pounds of aluminum foil every year.

Aluminum is one of the most durable packaging materials available. That's why it should always be recycled. If you throw an aluminum can out of your car window today, it will still litter the earth hundreds of years later.

One of the most innovative strategies in aluminum recycling is the reverse vending machine. These machines found in several areas of the state, take your cans and give you money!

Aluminum recycling is profitable for everyone. Companies recycling aluminum make as much as $2 million every day! Many communities use the profits from aluminum recycling to fund other recycling projects.

Other Metals

According to the Steel Can Recycling Institute, steel is the most recycled material in the United States with a 66 percent recycling rate. This high recycling rate is due to a combination of industrial and consumer recycling. Consumers recycle about 41 percent of the steel cans they use. Today, over three-fifths of all steel products contain an average of 25 percent recycled steel; almost two-fifths contains 100 percent recycled steel.

When we recycle "tinned" food cans, we are really recycling steel cans with a very thin coating of tin. Tin protects the steel from corroding or rusting.

Bimetal cans are tin cans with an aluminum top. These cans are not easily recycled because they contain three metals which must be separated for recycling.

You can tell the difference between tin (steel) and aluminum cans with a magnet. Magnets will attract steel but not aluminum. Bimetal cans also attract magnets. Magnetic separation makes steel easy to remove from other wastes.

Steel cans collected for recycling are detinned. The tin is reused and the steel taken to steel mills.

Every ton of steel recycled saves 2,500 pounds of iron ore, 1,000 pounds of coal, and 40 pounds of limestone that would be used in making steel from virgin materials.

The steel industry has also looked at source reduction as a way to reduce waste. Today, improvements in steelmaking quality and manufacturing methods have resulted in a net reduction in the amount of steel in many steel products. Steel cans, for example, contain an average of one-third less steel than the cans produced in 1975.

A Closer Look at Used Oil

Putting Used Oil In Its Place

Oil is the primary energy resource in developed countries. It powers our cars, heats our homes, and runs our factories. Oil is a nonrenewable resource, that is, a resource of limited quantity. Currently more than half of every barrel of oil used in America becomes vehicle fuel; and 13 percent goes to non-energy uses including plastics, petrochemicals, lubricants, asphalt, and coke.

Geologists report that it could be just 20 to 40 years before the easy-to-pump petroleum is spent, and we must turn to oil shale and offshore wells.

According to Norm Hinman, manager of the Alternative Fuels Program of the U.S. Department of Energy's Solar Energy Research Institute, "When we project out to the year 2030, it looks like we'll be importing about 80 percent of our oil."

With the future oil supply in question, it is surprising to find out that millions of gallons of used but useful oil are being poured on the ground and down the drain every year.

Mismanagement of used motor oil is a serious problem. Every year, privately owned cars and light trucks generate more than 800 million gallons of used crankcase oil nationally.

When changed at a service station or quick-lube shop, the oil will enter a managed system where it will be sent for re-refining or reprocessing. But not all used motor oil takes this route. According to the U.S. EPA, each year people who change their own oil – do-it-yourselfers – produce more than 210 million gallons of used motor oil, and only about 32 percent of this used oil is properly collected and recycled. The remaining portion, about 143 million gallons of used motor oil, ends up contaminating the environment. That's the equivalent of 14 Exxon *Valdez* spills per year.

How do 143 million gallons of used oil get from our cars into the environment? Well, studies show that this used oil comes from millions of well-intentioned do-it-yourselfers who change their own motor oil and then dispose of it improperly.

The South Carolina Department of Health and Environmental Control's Office of Solid Waste Reduction and Recycling estimates that nearly 1 million gallons of used motor oil are improperly disposed of each year in South Carolina. The S.C. Solid Waste Policy and Management Act of 1991 bans the disposal of used motor oil in municipal and county landfills after May 27, 1992. With these new regulations in effect, there are only two alternatives: either take motor oil to a used oil collection center for recycling, or break the law and dump it illegally into the environment.

While oil tanker accidents make the news, the United States Coast Guard estimates that sewage treatment plants discharge twice as much oil into coastal waters as do tanker accidents. A major source of this pollution is the one-pan-at-a-time dumping of used motor oil. A 1981 survey by the United States Department of Energy found that 68 percent of all do-it-yourself oil changers improperly dispose their used motor oil by burning it, dumping it, or finding other uses.

Used motor oil should never be emptied into sewers or storm drains, or dumped directly onto the ground to kill weeds or to suppress dust on dirt roads. Also used oil should never be thrown into the trash where it will end up in landfills.

A Little Goes A Long Way...

Unfortunately, even *a little* used oil can go a long way in polluting soil, streams, and lakes. Oil in any form can have an effect on our environment. Studies have shown that after a spill, it may take up to 20 years for the environment to recover to its original condition.

One gallon of used oil can potentially destroy 1 million gallons of fresh water – enough to supply 50 people with drinking water for a year.

One pint of oil can produce a slick on water about one acre in size and will kill floating aquatic organisms.

You can taste less than 300 parts per million of oil in fish and smell and taste only 5 parts per million of oil in water.

Why Collect Used Oil?

Recycling used oil makes good sense. Recycling motor oil not only eliminates a health hazard and protects the environment, it also saves energy.

All automotive oils can be recycled safely and productively. Used oil can be recycled and used again as a fuel, lubricant, or other petroleum products.

The durable qualities that make motor oil a fine lubricant also make it ideal for recycling. Motor oil never wears out. It just gets dirty. Through the process of re-refining, impurities are removed by heating and filtering, yielding "new" oil.

One gallon of used oil can make 2 1/2 quarts of lubricating oil, while it takes 42 gallons of crude oil to produce the same amount.

According to studies by the National Bureau of Standards, the Army, and the Department of Energy, re-refined oils perform as well as virgin oils. However, you should check your car's manual to see if re-refined oil is recommended.

Oil is a valuable resource that should never be thrown away.

Recycling Used Oil

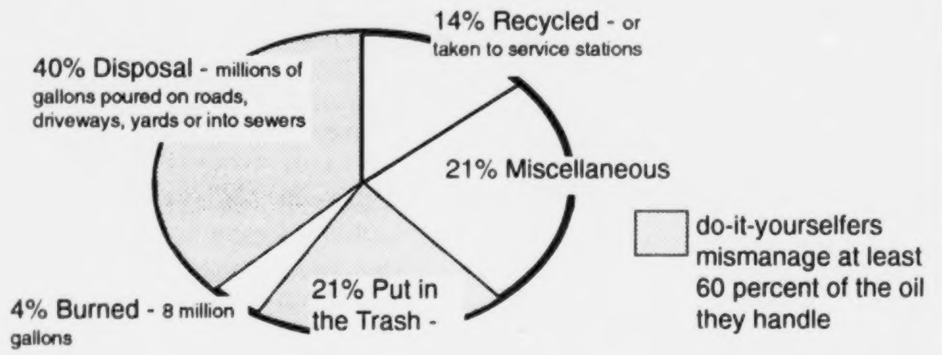
Used motor oil can also be recycled and used again as fuel. In power plants, used oil can be used as a fuel source to produce electricity.

Used oil has nearly 1 1/2 times the energy-producing value of coal. One gallon of used motor oil can be used to generate 18 kilowatthours of electricity.

Recycling used oil makes good sense. Recycling motor oil not only eliminates a health hazard and protects the environment, it also saves energy.

What Happens to Do-It-Yourself Oil Nationally

source: Analysis of Potential Used Oil Recovery from Individuals, Market Facts, Inc. 1991



Two gallons of used oil will provide the electricity to run the average household for about 24 hours, or

- cook 48 meals in the microwave
- blow dry your hair 216 times
- watch TV for 180 hours (7 1/2 days).

It's More than Just Oil

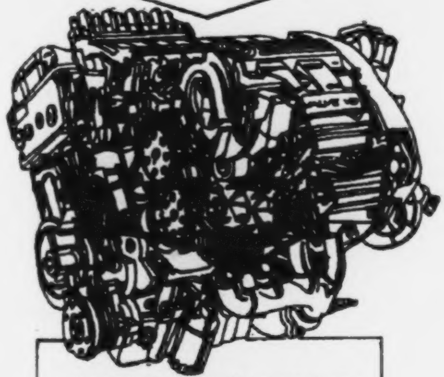
It's not just the damaging effects of the used oil that poses a threat to the environment. Used motor oil contains many additives and contaminants.

As much as 20 percent of automotive oil is composed of substances that are added to improve performance, such as to inhibit rust or prevent foaming. Oil will also pick up sediment and gasoline components and additives from the engine during combustion. Lead, as well as benzene, cadmium, zinc, and magnesium are all added to used oil and may contaminate the environment if not properly handled.

While used motor oil (the kind that comes from your automobile) has not been classified as hazardous waste by the U.S. EPA, many of the contaminants that used oil contains are considered toxic. Laws do regulate large quantities of used oil and used oil that contains high levels of hazardous substances.

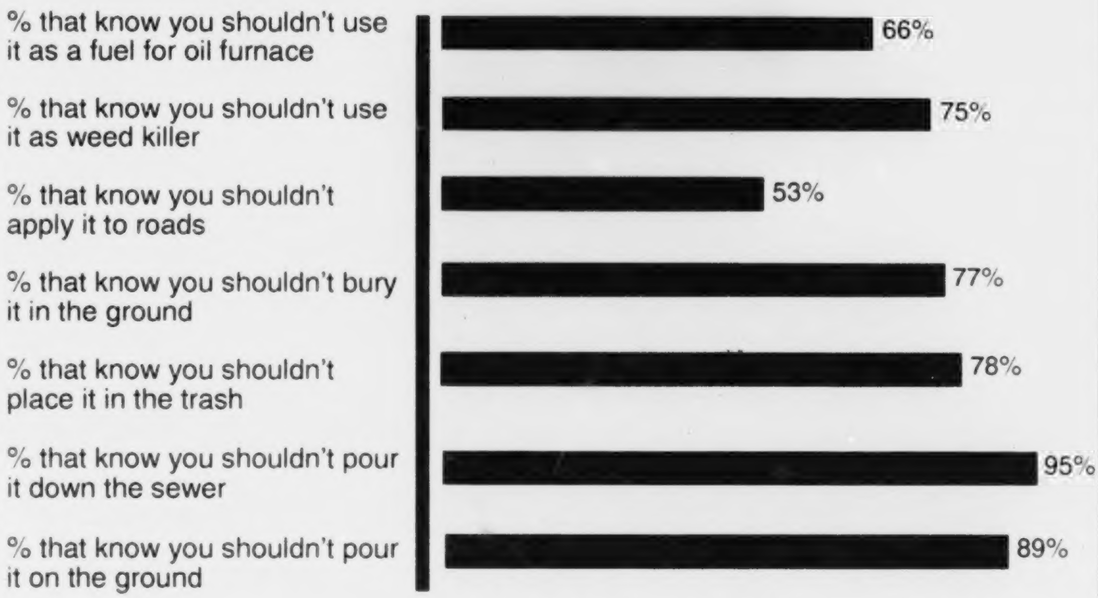
Your Engine's Oil: Coming & Going

New motor oil contains: pour point depressant; detergent; foam, oxidation, rust, and corrosion inhibitors; viscosity index improvers; anti-wear additives



Used motor oil contains: all the original ingredients PLUS water and dirt; iron and steel particulates; copper; heavy metals including lead, cadmium, zinc, and barium; sulfur; ash

Public Perceptions of the Harmfulness of Various Used Oil Practices



As this survey shows, most consumers recognize the damage that can be done by used oil, yet only about 30 percent of those changing their own oil have been recycling it.

Getting People Involved in Used Oil Recycling

According to the U.S. EPA's brochure, "How to Set Up a Local Program to Recycle Used Oil," if all used oil improperly disposed of by do-it-yourselfers were recycled, it could produce enough energy to power 360,000 homes each year or could provide 96 million quarts of high quality motor oil.

So, why doesn't everyone recycle their used motor oil? The U.S. EPA also reports that publicity about used oil recycling can triple do-it-yourselfer participation in local oil recycling programs. This is why many states, including South Carolina, have passed laws making improper disposal of used oil illegal and have sponsored aggressive advertising campaigns to promote used oil recycling.

How To Get Started

Do-it-yourself oil changers can collect their used oil by following these simple procedures:

- drain oil and pour into a clean, sturdy container with a tight-fitting, screw-on top
- never mix used motor oil with anything, such as antifreeze, gasoline, paint thinner, carburetor cleaner, solvents, or water
- use containers smaller than five gallons
- avoid plastic bottles once used for bleach, cleaners, and automobile fluids.

Used motor oil filters contain about one cup of oil that should be recycled. To recycle your oil filter:

- puncture the filter with a screwdriver
- drain the oil into your collection container.

Many service stations and quick lube shops will take used oil filters for recycling. These companies are required to recycle the used filters they collect.

South Carolina's Used Oil Success Story

In South Carolina, it is against the law to dump used oil into the environment or put it in the trash. The South Carolina Solid Waste Policy and Management Act of 1991 prohibits the disposal of used oil in county and municipal landfills. The Pollution Control Act also makes dumping used oil on the ground or in waterways illegal, with fines up to $200 and $10,000 respectively.

So, what can South Carolina's do-it-yourselfers do with their used oil? *Recycle It!*

For more information on used oil recycling and locations to recycle used oil in South Carolina, call 1 (800) 768-7348, or 1 (800) SO USE IT.

Used Oil Recycling Begins In S.C.

In 1990, as a part of local Earth Day activities in Moncks Corner and Myrtle Beach, Santee Cooper, the state-owned electric utility, collected more than 600 gallons of used motor oil in a single day. This demonstrated South Carolina's willingness to participate in used oil recycling.

Santee Cooper expanded its test with more collection sites in a program called GOFER (Give Oil For Energy Recovery). From eight sites, more than 4,000 gallons of used motor oil were collected in just six months.

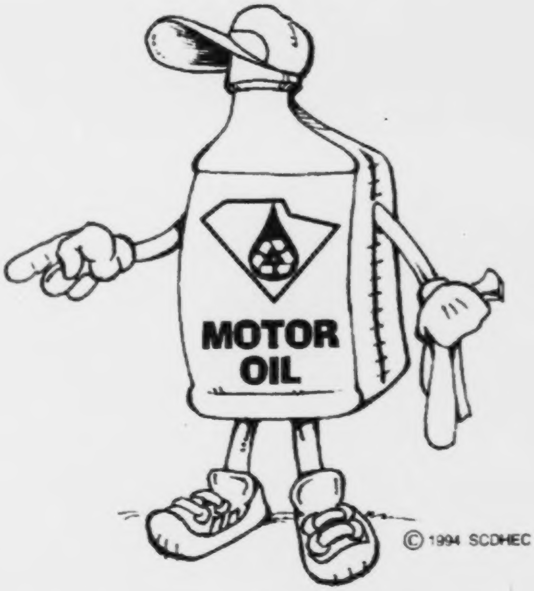
The S.C. Used Oil Partnership

With the encouragement of these test results, the S.C. Used Oil Partnership was formed to promote public awareness of the importance of proper disposal of used motor oil. In addition to Santee Cooper, this public-private partnership consists of the S.C. Department of Health and Environmental Control, the S.C. Department of Transportation, and the S.C. Petroleum Council.

The statewide used oil recycling awareness campaign features NASCAR driver Jeff Gordon as the spokesperson for used oil recycling.

In 1992, the program's first full year, almost 300 collection sites brought in more than 250,000 gallons of used oil from do-it-yourselfers.

This represented a 25 percent recovery of the estimated 1 million gallons of used oil that are improperly disposed of each year in this state. In 1995, more than 600,000 gallons were collected. Most of this used oil is recovered as fuel and is burned in Santee Cooper's generating stations in Georgetown (the Winyah Station) and in Moncks Corner (the Jefferies Station.) These plants typically use coal as an energy source and are specially equipped to burn used oil as fuel.



To recycle oil, just take it to one of the many used oil collection sites around the state such as Santee Cooper's GOFER (Give Oil For Energy Recovery) program. Many service stations also take used oil.

Today, the program collects more than 1,000 gallons of used motor oil a day. Collection sites statewide have collected more than 600,000 gallons of used motor oil. With more sites being added, used oil recycling in South Carolina is a success story that demonstrates that South Carolinians are eager to protect our environment.

From You to the Environment

If you pour used motor oil in a storm drain or ditch, or anywhere in your backyard, there's a good chance that the oil will end up in a nearby stream, river, or lake. The storm drain is the metal or concrete opening at the sides or curbs of streets. They are also called catch basins. When it rains, the first drops of water soak into the ground, but the excess or runoff goes into these storm drains.

From the storm drain, this runoff enters pipes that carry it to larger pipes buried under the ground. These pipes empty the water into the nearest drywell or waterway. This can be a creek, river, or lake. So if you pour used motor oil on the ground or down the storm drain, it may end up on the feathers of ducks or the gills of fish in a nearby lake.

In some areas, the storm drain joins sanitary sewer pipes and the runoff goes to a sewage treatment plant. The amount of treatment varies from community to community and it is expensive.

In areas where there are no storm drains and used motor oil is dumped into the ground, it runs with rain water to the nearest ditch or gully and on to the nearest waterway. Oil dumped on the ground may also seep down with rain into the groundwater.

Water drains or soaks into the ground until it hits a layer that it can not soak through, an impermeable layer. The water then collects in the spaces between sand, gravel, or rock. Underground areas where groundwater collects are called aquifers. Some aquifers replenish lakes or streams. Others are enclosed by layers of rock and do not move. Wells are drilled into both kinds of aquifers. Aquifers around the country are becoming contaminated at an alarming rate by used motor oil and other harmful substances that are disposed of improperly.

While the motion of water and the natural purification properties of sand and clay do work to filter many impurities out of water, this natural cleansing can not keep pace with the pollution that is flowing into our water systems.

When you pour used oil down the drain, it goes to the municipal sewage treatment system or into a septic tank. These systems are not designed to deal with used oil or the contaminants that used motor oil contains.

While the problems caused by disposing of used oil by pouring it out may seem obvious, many of these same water contamination problems can occur when used motor oil is thrown into the trash.

With the passage of the South Carolina Solid Waste Policy and Management Act of 1991, used oil is banned from disposal in our landfills. This means that used oil should never be put into your trash.

Used motor oil, disposed in landfills built before today's strict, federal Subtitle D regulations, can also find its way down through the soil to our groundwater.

With the passage of the
South Carolina Solid Waste
Policy and Management Act
of 1991
used oil is banned from disposal
in our landfills. This means that
used oil should never be
put into your trash.

Used Oil and the Environment

In addition to ground water pollution, a film of oil on the surface of the water can block photosynthesis and slow the production of oxygen. The reduced oxygen supply then causes stress to the point of death in aquatic organisms. Large organisms such as mammals and birds are the most familiar victims of oil pollution because of their visibility and emotional struggle to combat oil in the environment. Feathers and fur stick together, become matted and lose their ability to insulate the animal against cold. Death may result from temperature shock or from the eating of oil as it is cleaned from their coats.

Oil can also clog breathing structures or be absorbed into tissue and passed along the food chain, even to humans who eat fish or shellfish. Microscopically, oil may harm bacteria or plankton, the basis of the food chain.

According to *Global Ecology* by Colin Tudge, Oxford University Press, 1991, oil entering our environment does devastating harm:

> "It [an oil spill] is obliterative; it renders huge areas of habitat inaccessible. Thus it reduces all populations with which it comes into contact, and would certainly render some of them locally extinct.
>
> "The effect is made worse because individual marine species tend to piece their habitats together from various components: plankton, inter-tidal zone, and so on. Damage to any one component will affect parts of the system elsewhere. Then again, all the creatures are inevitably locked into a food web. If one is affected, then all the others are affected as well."

More Facts About Used Oil

• The total generation of used oil increased by 2 percent between 1988 and 1991, from 1.35 billion gallons to about 1.38 billion gallons. Total generation numbers include the oil used by private automobiles, trucks and other transportation as well as commercial and industrial sources.

• The growing interest in recycling used oil is keeping more used oil out of landfills. Reflecting the increased interest in recycling, the proportion of used oil disposed in landfills, incinerated, and dumped on the ground and down sewers dropped from 33 percent in 1988 to 28 percent in 1991.

• Currently, 11 major oil companies have formal programs in place to support and encourage service station owners to accept used oil from do-it-yourselfers. More than 1,000 communities across the country have initiated drop-off and curbside programs to collect oil from do-it-yourselfers.

• In 1983 it was estimated that as much as 68 million gallons of used oil were spread on gravel and dirt roads as a dust suppressant, commonly referred to as road oiling. By 1988 less than 34 million gallons were used for this purpose. Today, 30 states prohibit the practice of road oiling with used oil, and 14 states regulate the practice.

• Because the practice of illegal dumping of used oil is seldom directly observed, estimates of the amount of used oil dumped on the ground are based on the amount of used oil generated which can not otherwise be accounted for.

source: Perspectives on the Generation and Management of Used Oil in the U.S. in 1991

Excerpts from

“THE WASTE OIL MONSTER”

by John Grassy
Garbage magazine, 1991

More than 780 million gallons of motor oil go in and out of American cars each year. When changed at a service station or quick-lube shop, the oil will enter a managed system, where it will be trucked off for re-refining or reprocessing. But only about half of the motor oil used annually takes this route. The other 367 million gallons keep environmentalists awake at night. This is DIY oil (Do-It Yourselfer), the oil of the back-yard mechanic who prefers to save some money and do the job at home.

A 1981 survey by the U.S. Department of Energy found that 61 percent of all DIYs improperly dispose their used oil, burning it, dumping it, or finding creative reuses.

Oil poured on the ground doesn't evaporate — it sinks in. Poured down storm sewers, it begrimes pipe walls, gums up screens in the treatment plant, or may even bypass treatment and go straight into a waterway. The Coast Guard estimates that more oil dribbles from the land into coastal waters each year than is spilled in tanker accidents. All this oil re-enters the environment with a toxic load significantly higher than that of virgin crude. Used oil has traces of the lead, arsenic, cadmium, chromium, barium, and zinc that accumulate in the engine. By land or by water, oil oozes into groundwater supplies and the food chain.

Just one pint of oil can make a one-acre slick on a lake or stream, and the resulting film impedes the replenishment of dissolved oxygen by blocking out sunlight needed for photo-synthesis. One quart of 10w-40 will foul the taste of 250,000 gallons of H_2O. And for oil to disappear, it must be eaten by microorganisms. These tiny creatures need oxygen, too, and as they multiply to consume the oil, they can deplete the oxygen available to fish and other aquatic life.

Let no one say ours is not an oil-rich nation. We deposit more than 200 million gallons of it in our soil and waterways every year, not counting what's drained from the likes of lawn mowers, weed whips, and boats. With so much oil running loose every year, how can it be we've heard so little about the problem?

Julie Stoneman, for five years the director of Michigan's long-running used-oil recycling program, says it's too easy to dump oil and get away with it. “Oil is a liquid,” she says. “You can't see a mountain of oil, like you can plastic or paper. It's dumped in small quantities over wide geographic areas. You don't see it and you can't trace it.”

MICHIGAN MOPS UP

Thanks in part to rising environmental awareness, used motor oil is beginning to get the attention it deserves — as both an environmental problem and a recyclable commodity. It wasn't so long ago that states were “oiling” dirt roads to control dust. But many of these states have now passed laws banning used oil from landfills, and they've instituted fines for improper disposal. A handful of states have even mounted impressive collection efforts.

Michigan's program started in 1979. Crude-oil prices were sky-high, and automakers were scrambling to design fuel-efficient cars. The Energy Crisis was in full bloom. Started as a volunteer project by Grand Rapids' non-profit West Michigan Environmental Action Council, the program's concept was simple: funnel DIY [Do-It-Yourselfer] oil into the existing collection system serving business and industry. The staff and volunteers recruited service stations, quick-lube shops, and car dealerships – places already equipped to handle oil. A small budget of $25,000 paid for promotion materials, staff time, and a toll-free number directing DIYs to the nearest collection site.

They sponsored workshops on oil pollution and recycling, and recruited more collection sites. They packaged the tasks of education, recruitment; even building collection sites, into projects for youth groups such as 4-H. The coalition grew to include public health departments, environmental groups, the state's soil-conservation districts, and the business sector, all working to educate DIYs and maintain public collection sites.

While the number of collection sites continues to fluctuate (currently there are 567 in 62 Michigan counties), the amount of oil diverted has climbed every year, proof that people will recycle oil when they know how.

Slippery Economics

These days, there's simply no money in collecting used motor oil from the public. The market value of used oil rises and falls with the price of virgin crude. In the late 1970s and early '80s, high oil prices spurred interest in used oil. The haulers that picked up used oil from service stations were paying for it. The private sector's profit motive was good news for recycling: Drop off that dirty old oil at my tune and lube? Sure! Then the bottom fell out of world oil prices during the "oil glut" of the mid '80s. Before long, haulers were charging to take used oil away. With the brief exception of the Persian Gulf War, the value of used motor oil has been sliding ever since, as has the number of collection sites in Michigan.

Volunteer operations are especially vulnerable to legal and financial perils. "Most of the newer recycling programs are institutionalized within state government," says Mr. Johnson, who looks to programs in Florida and Maryland as models of stability.

Florida looked at its used-motor-oil pollution and jumped. State environmental officials don't mince words about the potential threat of DIY oil: Groundwater lying just six or seven feet underground provides more than 90 percent of the state's drinking water. Kicking off the program last fall, then secretary of Florida's environment bureau Dale Twachtmann said, "We estimate that around seven million gallons of oil from do-it-yourself mechanics are improperly disposed of each year in Florida. That's the kind of battering no state can take over a long period."

Florida backed its words with action, launching an aggressive public-education campaign (including a school-based program) and local and county-wide collection programs. In 1988-89, over $1 million in grants went out to 54 counties, six cities, and one Indian tribe. "Everyone who requested a grant was funded," says Betsy Galocy, coordinator of the oil program. "The result was about 200 new collection sites." Counties and municipalities that operate collection sites also receive partial liability protection from spills or contamination, courtesy of the state.

Curbside collection programs now operate in Charlotte and Hernando counties; a third county, San Luce, features a mobile oil-collection vehicle, which serves 11 pickup points each month. Augmenting the state's efforts, the oil biz has opened its tanks to DIYs. About 450 of Florida's 650 collection sites are Mobil, Amoco, BP America, and Texaco service stations.

Burn It Or Bottle It?

The durable qualities that make motor oil a fine lubricant also make it ideal for recycling. During its workout in the crankcase, additives in the oil may break down, and the oil darkens as it collects contaminants. Through the process of re-refining, these impurities are removed by heating and filtering, yielding "new" oil.

It used to be that virgin crude oil required no special processing — most oil in the world was of motor-oil quality when it came out of the ground. But as we've dipped deeper into the world's reserves, overall quality has declined. Producing motor oil from today's crude is a costly, elaborate process: 42 gallons of crude oil yield just 2.5 quarts of virgin motor oil, along with some other products. Re-refining, on the other hand, is much more efficient: Only one gallon of used oil is needed to produce the same 2.5 quarts of quality lubricant (plus by-products).

However, the vast majority of collected oil isn't re-refined. It's reprocessed. Reprocessing involves blending the used oil with virgin stock to make industrial heating fuel. About 80 percent of the DIY oil collected in the U.S. takes this route. Reprocessing has benefits — it reduces virgin-oil consumption and saves money — but in the eyes of some environmentalists, burning high-quality motor oil is no victory for recycling. "These are our finest-quality lubricating oils," says Ms. Stoneman. "Reprocessing is better than dumping, but reprocessing is using that oil only once [more]."

There's a good explanation for the mere trickle of oil that's re-refined: Only seven re-refineries have been running in North America, and just three were considered sizable operations with current technology. And only one of those, Evergreen Oil of Newark, Calif., is in the U.S. The Evergreen plant takes in about 12 million gallons of used oil each year.

U.S. re-refining took a quantum leap this past April, though, with the opening of the SafetyKleen Corp. re-refinery in East Chicago, Ind. Outfitted with the latest technology and capable of processing 75 million gallons of used oil annually, the plant is the largest re-refinery in the world, and roughly triples U.S. capacity.

Small, independent re-refineries flourished years ago, and memories of the substandard products of that time haven't disappeared. Skeptics question the overall consistency of "used oil" and say it can't possibly be as reliable as new stock. But a spokesman notes that SafetyKleen oils have passed the toughest tests, including the specifications for U.S. military machinery.

New York State is among the fans of re-refined. In 1990, the state bought more than 76,000 gallons for use by municipalities and school districts. "It was low bid, and it met our specifications," says Steve Pryor, a purchasing officer in Albany. "We didn't do anything different in purchasing procedures; the product simply became available."

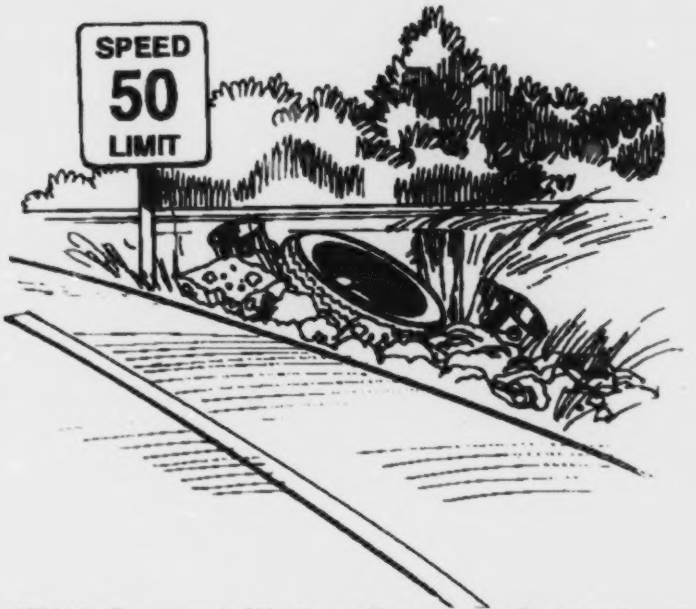
For used-oil recycling to gain even more momentum, says Julie Stoneman, action is needed on all fronts at once. Leaders at the state and local levels need the facts about used-oil pollution, and they need models for collection programs. The business sector needs to participate at both ends of the recycling cycle. "That means taking DIY oil if you're a service station, and stocking re-refined oil if you're a major retailer," she says. And finally, more do-it-yourselfers need to realize just what it is they're throwing away. Motor oil may originate in the Earth, but after refining and a 7,000-mile run in a crankcase, it shouldn't be sent home again.

A Closer Look At Tires

Some 240 million tires are discarded annually in the United States. And billions of used tires are buried in landfills across the country. Considering it takes about half a barrel of crude oil to produce the rubber in just one truck tire, this is a waste of valuable resources. source: *50 Simple Things You Can Do To Save The Earth*

More than 50 percent of the nation's rubber is used to make tires.

According to the U.S. EPA, *Summary of Markets for Scrap Tires*, scrap tire generation has grown by about 2 percent per year since 1984. Less than 7 percent of these scrap tires are recycled as products, approximately 11 percent are incinerated for their fuel value. Another 4 percent are exported, and the final 78 percent are disposed in landfills, stockpiled or illegally dumped.



In 1991, the Department of Health and Environmental Control estimated that nearly four million waste tires were stockpiled in locations throughout the state. According to the U.S. EPA, 78 percent of all scrap waste tires are disposed of in landfills, stockpiled or illegally dumped. In South Carolina, whole used tires are banned from disposal in landfills.

What can we do about tires?

One of the best things to do is to keep your tires from becoming waste tires by taking care of them. Keeping tires properly inflated makes them last longer by reducing wear and saves fuel because tires roll with less resistance.

The typical American driver rides on under inflated tires – that's 65 million of us. Besides wearing tires out faster, underinflated tires decrease gas mileage by up to five percent.

Improvements in tire manufacturing over the past forty years have more than doubled the useful life of tires. Currently, steel-belted radial tires last about 40,000 miles. If tires are properly inflated, rotated, and otherwise properly cared for, 60,000 to 80,000-mile lifetimes can be achieved.

Retreading is Recycling

In the past, recyclers turned old tires into new ones by retreading them. Retreading is the application of new tread to a worn tire that still has a good casing.

Currently over 1,900 retreaders operate in the United States, but that number is shrinking because of declining markets for passenger retreads. This decline is due to the relatively low price of new tires and concerns about the safety. Truck tires, however, are often retreaded three times before they are discarded, and the truck tire retreading business is increasing.

According to the Tire Retread Information Bureau, retreaded tires are processed according to the Federal Safety Standards developed by the U.S. Department of Transportation. Commercial aircraft retreaded tires are approved by the Federal Aviation Administration. This organization promotes tire retreading as a form of recycling.

In 1989, the U.S. EPA established buying guidelines for the government that promotes the use of retread tires.

Recycling Tires into ...

Recycling tires into new products is still a fairly untapped area. The energy used to produce a pound of virgin rubber is 15,700 Btus. Producing one pound of recycled rubber requires only 4,600 Btus – a savings of 71 percent.

Each year, approximately 3 percent of the total number of tires discarded annually are used to make crumb rubber that is recycled for adhesives, wire and pipe insulation, brake linings, conveyor belts, carpet padding, lawn mower and tracker tires, hoses, sporting goods and many other products.

Ground rubber pieces can be added to asphalt for paving roads, runways, playgrounds and running tracks. **Rubber added to asphalt is reported to increase pavement life by 4 or 5 times and reduce the amount of resurfacing materials required.**

Today's steel belted radials make recycling harder and rubber recyclers are turning to more creative outlets for recycled rubber.

THE TYPICAL AMERICAN DRIVER RIDES ON UNDER INFLATED TIRES – THAT'S 65 MILLION OF US. BESIDES WEARING TIRES OUT FASTER, UNDERINFLATED TIRES DECREASE GAS MILEAGE BY UP TO FIVE PERCENT.

Today only about 38 million of the 240 million scrap tires generated each year in the United States see a second life, according to Recycling Research, Inc.

Whole tires are used for erosion control, for highway barriers, as artificial reefs, and for playground equipment. Tires may be split or punched to produce floor mats, gaskets, dock bumpers, and shoe soles.

New markets for scrap tires are in development. Most people see fuel chips, known as tire-derived fuel, as the most promising short-term market and rubber-modified asphalt as the most viable long-term solution.

A study by the Scrap Tire Management Council identified these markets as well as facilities that burn whole tires for energy, as meeting its criteria of being environmentally acceptable, economically feasible and capable of significantly reducing the volume of scrap tires.

According to the U.S. EPA, in the past three years, the use of scrap tires as a fuel has increased significantly. **Scrap tires make an excellent fuel because they have a heat value slightly higher than that of coal, about 12,000 to 16,000 Btus per pound.**

On a national basis, they represent a significant potential energy source. The U.S. EPA reports that tire burning facilities can meet federal and state emission standards.

Combustion facilities that currently use tires as fuel include power plants, tire manufacturing plants, cement kilns and pulp and paper mills. Although whole tires require lower processing costs as a fuel resource, most power plants are equipped to incinerate only tires shredded into tire-derived fuels.

In several other countries – particularly West Germany, Austria, France, Greece and Japan – incinerating of tires is more common than it is here.

Hastening the development of alternate strategies in our country is legislation limiting or prohibiting the landfilling of tires.

South Carolina includes waste tires among seven wastes that are classified as "special wastes" that require separate management provisions by the Solid Waste Policy and Management Act. Whole waste tires are banned from disposal in municipal solid waste landfills.

In 1991, the Department of Health and Environmental Control (DHEC) prepared a report on waste tire management and disposal. It was estimated that nearly 4 million waste tires were stockpiled in locations around the state. In 1992, records indicate that

Keep Your Rubber on the Road

The best way to minimize personal tire waste is to buy long-lasting tires and keep them properly inflated, which will also increase your gas mileage by as much as five percent.

Rotate and balance your tires every 6,000 miles. If possible, buy tires from dealers who recycle old tires.

approximately 3.6 million *additional* waste tires were generated. If not adequately addressed, this solid waste management challenge would become a nightmare.

The Solid Waste Policy and Management Act establishes a $2.00 fee on each new tire sold in the state. From this fee, monies are generated for distribution to each county for the collection and disposal of waste tires; for reimbursement of the administrative costs of the tire retailer or wholesaler; and for the establishment of the Solid Waste Management Trust Fund. Grants are funded to help local governments remove stockpiled waste tires and to develop waste tire management alternatives.

In 1993, 33,749 tons of waste tires were collected for recycling. Currently S.C. DHEC has approved more than 10 tire management facilities. These offer options that include waste tires as a fuel in boilers, using waste tires as a substitute for gravel in septic tank drain lines, and using tires to produce artificial reefs in the ocean.

Sources: Tire Industry Safety Council, P.O. Box 1801, Washington, DC 20013
Tires Are Bouncing Back
Recycling Today, August 1991
The League of Women Voters Education Fund, Garbage Primer, 1993

A Closer Look At Hazardous Wastes

If you own a bicycle or a tennis ball, or if your family has a car, you have things that are made with materials that are considered hazardous if handled improperly. Hazardous wastes are a fact of modern life.

Hazardous wastes are byproducts of many manufacturing processes. **Hazardous waste can be a solid, liquid or gas.** About 10 to 15 percent of all waste generated in the United States is hazardous.

Hazardous waste has certain characteristics that make it potentially harmful. It may be **toxic, corrosive, ignitable** or **explosive.**

Medicines, televisions, computers, even tennis shoes – almost anything that you can think of that has been manufactured, contains hazardous materials of some kind or produced a hazardous byproduct when it was manufactured. Of course, this does not mean that the item itself is hazardous. For example, putting the colors in paints and fabrics generates hazardous waste. So does the manufacture of many metal, plastic, and even wood products. De-inking newspapers before they can be recycled produces a hazardous waste byproduct.

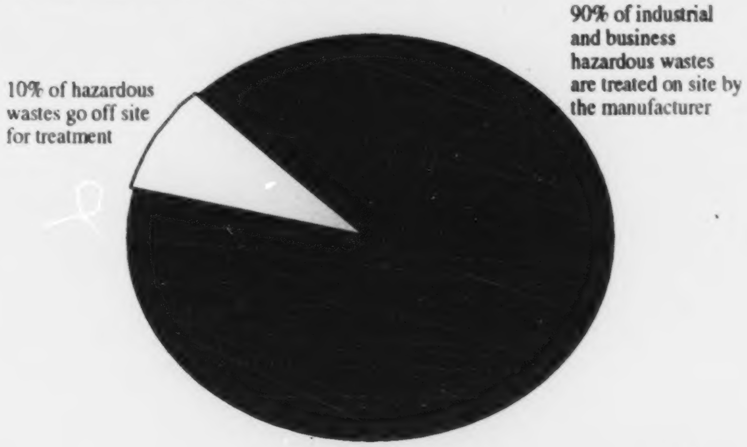
For every single person in the United States, about one ton of hazardous waste byproducts – the stuff that is left over after something is made – is generated *every year.*

Did you know that more than 100 separate hazardous materials are used just to make a bicycle, and about 50 separate hazardous materials are used to make one tennis ball?

According to the book, *Earth in the Balance*, by Vice President Al Gore, in the United States there are an estimated 650,000 commercial and industrial sources of hazardous waste; the U.S. EPA believes that 99 percent of this waste comes from only 2 percent of these sources. An estimated 64 percent of all hazardous waste (managed off site) is managed at only 10 regulated facilities. About 60 percent of all hazardous waste comes from chemical manufacturing, about 25 percent from the production of metals and machinery, 11 percent is divided between petroleum refining (3 percent) and 100 smaller categories.

Hazardous wastes must be handled carefully. There are laws to regulate how factories and businesses handle and dispose of their hazardous wastes.

About 90 percent of the hazardous waste generated in the United States is treated right at the factory where it is created. The other 10 percent is taken to special federally regulated and permitted facilities for treatment. Hazardous wastes may be recycled, burned, treated with chemicals, or buried in a special hazardous waste landfill.



Hazardous Waste Classifications

Ignitability - Ignitable wastes are liquids with a flash point less than 140°F for flammable gases, strong oxidizers or substances which burn vigorously under spontaneous circumstances. Besides potential hazards from fire, heat and toxic smoke, they can spread harmful particles over a large area. Examples include solvents such as toluene, xylene and benzene; oils; plasticizers; and paint and varnish removers.

Corrosivity - Corrosive wastes are substances which can, upon contact, cause destruction of living tissues and materials by chemical action. They are generally water based wastes with a pH less than or equal to 2 (acids) or greater than or equal to 12.5 (bases). Because they may corrode standard materials, such as steel, corrosive wastes require special containers. Examples: alkaline cleaners and battery wastes.

Reactivity - These are wastes that are normally unstable, may spontaneously and vigorously react with air or water, be unstable to shock or heat, generate toxic gases when mixed with water and/or explode. Examples include obsolete munitions, cyanide- and sulfide-bearing wastes, and wastes from the explosives and chemical industries.

Toxicity - Toxicity is measured by the potential for a waste to release substances in sufficient quantities to pose a substantial hazard to human health, domestic livestock and/or wildlife through ingestion, inhalation or absorption. The U.S. EPA has identified maximum concentrations of heavy metals, pesticides and herbicides over which significant risk to human health may occur. These concentration limits are set at a level 10 times the U.S. EPA/Primary Drinking Water Standard.

SPARKLE
GLASS CLEANER

Household Hazardous Waste

The average American stores three to 10 gallons of household hazardous products at any given time. Examples of household products which contain toxic or polluting chemicals include paints, septic tank cleaners, fingernail polish, drain cleaners, disinfectants, pool chemicals, pesticides, hobby supplies, car batteries and laundry bleach.

People are generally unaware of the potential dangers of using, storing and disposing of common household substances. Some potentially severe consequences of careless disposal of these products include:

- **pollution** of drinking water, ponds, harbors and rivers
- **injury** to trash collectors (chemicals when mixed together can cause fires, acid burns and the release of toxic fumes)
- **smog and other air pollution** is caused by evaporation of solvents contained in products such as household paints, varnish strippers and even fingernail polish
- **injury** to firefighters battling fires involving large amounts of flammable substances such as gasoline, paint thinner and pesticides
- **destruction of important bacteria** necessary to break down wastes in sewer and septic tank systems.

Hazardous Waste Around the World...

- Germany is home to more than 34,000 abandoned toxic waste sites.
- Industrial emissions blowing from China have caused severe acid rain throughout Japan. In a study in 1991, scientists found acidity in snow almost equal to that in orange juice.
- Battery recycling is done routinely in Europe and Japan.
- The United States and Canada maintain the highest environmental standards of any other counties in the world. Source: 1993 Earth Journal

The most important law concerning hazardous waste is the Resource Conservation and Recovery Act (RCRA). Passed in 1976, it has been amended to tighten regulation of hazardous substances. RCRA:

- determines which wastes are hazardous
- creates rules for handling and disposing of these wastes
- makes sure wastes are transported safely if they leave the generation site
- makes sure any spilled or mismanaged wastes are cleaned up
- keeps track of all the hazardous wastes created in this country.

In 1984 RCRA was amended by the Hazardous and Solid Waste Amendments. These amendments changed the focus of waste management in many ways, including the development of minimum technology requirements.

The **Comprehensive Environmental Response Compensation and Liability Act,** or **CERCLA,** was enacted in 1980 and created a "Superfund" to provide money for cleanup of abandoned and/or inactive waste sites.

CERCLA was amended in1986 with the **Superfund Amendments and Reauthorization Acts**, or **SARA**. These amendments provide additional money for cleanup, involve the public in decision-making processes, and encourage states to participate with the U.S. EPA to address these sites.

When we think of hazardous wastes and materials, we may think of chemicals and thick fumes. In reality, hazardous wastes are generated every day by industries, agriculture, the military, small businesses, public agencies, institutions, and homeowners. Originally RCRA was written to regulate hazardous waste produced by the **large quantity generators**: industries, agriculture, and the military. Large quantity generators generate more than 1,000 kilograms of hazardous waste per month.

RCRA has since been amended to regulate the previously exempted **small quantity generators** including small businesses, public agencies, and institutions such as schools, hospitals, and maintenance crews. Small quantity generators are those which generate less than 1,000 kilograms of hazardous waste in a calendar month. Some small quantity generators are conditionally exempt.

The small amount of hazardous wastes found in homes, **household hazardous waste**, has remained exempt from federal regulations.

Small businesses that are likely to produce hazardous wastes include those that: repair and maintain motor vehicles, electroplate materials, operate printing and copying equipment, perform dry cleaning and laundering services, process photographs, operate laboratories, construct buildings and roads, spray lawns and/or homes for pest control, preserve wood, make or refinish furniture, paint and clean buildings, clean and maintain swimming pools, repair air conditioners, and make and glaze ceramic pottery.

The actual amount of hazardous waste generated by a single small business or school may seem insignificant, but the amount from all these sources adds up to a profound threat to the environment if not properly handled.

To identify and properly manage the hazardous waste produced by small quantity generators (SQGs), South Carolina requires reporting annually by companies generating between 100 kilograms and 1,000 kilograms per month. For 1992, 1,046 small quantity generators reported.

Although the majority of small quantity generators are small businesses, many schools also generate significant amounts of hazardous wastes. Often, these wastes are improperly disposed by unknowing teachers, custodians, and clerical staff who pour hazardous wastes down sink drains, dump them on the ground or in storm drains, bury them in containers which can leak over time, or put them in garbage cans or dumpsters for disposal in municipal landfills. Improperly managed hazardous waste can pollute our ground water, contaminate rivers and lakes, kill fish and other wildlife, pollute the air with toxic vapors, cause explosions or fires, and poison humans from direct contact or consumption of contaminated plants and animals.

Many hazardous waste generators – especially large quantity generators – treat, store, or dispose of wastes on site under federal and state regulations. The technology and equipment for this activity is expensive and usually too costly for small quantity generators. The most economical way for small quantity generators to manage their hazardous waste is to have it shipped to approved facilities.

Like any other kind of waste, the less hazardous waste a generator produces, the easier it is to manage. Small quantity generators can reduce the amount of hazardous waste they produce by recycling waste materials, participating in waste exchanges with other small quantity generators, and using alternative nonhazardous substitutes for potentially hazardous products. Hazardous wastes that can be recycled for further use include lead in car batteries, and silver from used photographic fixer. In many cases, one generator's hazardous waste can be another industry's raw material.

In our area, small and large quantity generators can call the Southeast Waste Exchange in Charlotte, North Carolina and list their wastes in a publication that is circulated to other generators, recyclers, and waste brokers.

Hazardous Waste in South Carolina

In March 1978, the General Assembly of South Carolina approved a regulatory program for the management of hazardous wastes. This legislation, known as the **South Carolina Hazardous Waste Management Act**, (Act 436) established the statutory framework necessary for the South Carolina Department of Health and Environmental Control, DHEC, to regulate hazardous waste activities within the state.

There are five (5) major elements in the state's approach to hazardous waste management:
(1) classification of hazardous wastes; (2) cradle-to-grave tracking (manifest system); (3) quarterly reporting; (4) standards to be followed by generators, transporters, and facilities which treat, store or dispose of hazardous waste; and
(5) enforcement of standards for facilities through a compliance monitoring, enforcement and permitting process.

A method of establishing wastes as hazardous involves the listing of specified industrial activities or substances presumed to be hazardous.

These categories are:
Wastes From Non-Specific Sources - wastes of the same genetic type used universally as multi-purpose chemicals, for example halogenated solvents.
Wastes From Specific Industrial Processes wastes generated by a specific industry, for example distillation bottoms from the production of acetaldehyde from ethylene.
Off-Spec Commercial Chemicals wastes from off specification materials, discarded commercial chemical products, container residues and spill residues including:

- about 200 chemicals considered "acutely hazardous" and regulated if more than 1 kilogram per month is generated.
- about 400 chemicals subject to regulations.

The state also includes a listing of hazardous wastes which are not properly identified by any existing or valid waste number.

Once wastes are identified as hazardous, their generation, transportation, treatment, and storage or disposal are managed. Minimum standards are specified in DHEC's regulations for each of these management categories. These standards include record keeping; facility design, construction, and operational requirements; permitting procedures; financial responsibility; and compliance self monitoring where applicable.

DHEC's staff responsible for implementing this program consists of engineers, hydrologists, chemists, geologists and other technical and clerical employees. These personnel are responsible for all hazardous waste activities including program administration; permitting; public participation compliance and surveillance; enforcement; field inspections and investigations; emergency response to spills and releases; and cleanup activities at uncontrolled sites.

Volume of Hazardous Wastes in South Carolina

Hazardous waste volume figures include significant amounts of hazardous wastewater. According to *Hazardous Waste Activities Reported for South Carolina for 1993* published by DHEC, 177,647 tons of the total 323,341 tons of hazardous waste generated in 1993 were hazardous wastewater.

In 1993, South Carolina generators shipped 155,514 tons of hazardous waste off-site. A total of 312,892 tons of hazardous waste were received by commercial off-site facilities in Carolina from in-state and out-of-state sources. As these figures indicate, **South Carolina is a net importer of hazardous wastes.**

According to the 1993 Hazardous Waste Activities Report, in general most of the hazardous wastes generated by

Using Cleaning Products Safely

The safest cleaners of all reside in many of the products you already have at home: baking soda, vinegar, lemon juice, vegetable oil, borax and hot water, for example. If you are unable to substitute a safer cleaning product for a hazardous one, it is important to follow these safety steps.

- Read all labels carefully before using hazardous products. Be aware of their uses and dangers.

- Leave products in their original containers with the label that clearly identifies the contents. Never put hazardous products in food or beverage containers.

- Do not mix products unless instructed to do so by label directions. This can cause explosive or poisonous chemical reactions. Even different brands of the same product may contain incompatible ingredients.

- If you are pregnant, avoid toxic chemical exposure as much as possible. Many toxic products have not been tested for their effects on unborn children.

- Avoid wearing soft contact lenses when working with solvents and pesticides. They can absorb vapors from the air and hold the chemicals near the eye.

- Use products in well-ventilated areas to avoid inhaling fumes. Work outdoor whenever possible.

- Do not eat, drink or smoke while using hazardous products. Traces of hazardous chemicals can be carried from hand to mouth. Smoking can start a fire if the product is flammable.

- Make sure containers are kept dry to prevent corrosion.

- Store volatile chemicals or products that warn of vapors or fumes in a well-ventilated area, out of reach of children.

- Store gasoline only in approved containers, away from all sources of heat, flame or sparks in a well-ventilated area.

- Store rags used with flammable products (including furniture stripper, paint remover and gasoline) in a sealed container.

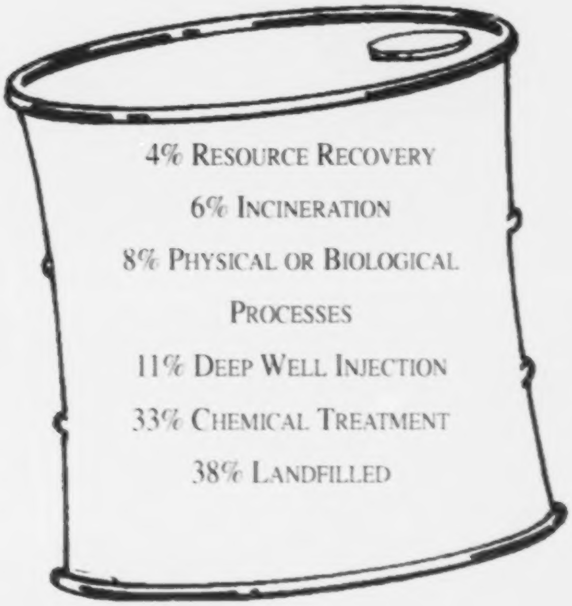
South Carolina companies remained in the state to be treated on-site or by commercial off-site facilities within the state. As much as 80 percent of the hazardous wastes commercially treated, stored, disposed, or recovered by South Carolina facilities were received from sources outside the state. The remaining 20 percent were received from South Carolina generators. Approximately two-and one-half times as much waste is being shipped into South Carolina compared to what is shipped out from the state.

Hazardous Waste Facilities

South Carolina has one commercial hazardous waste landfill, one of only two facilities in the Southeast. The hazardous waste landfill is located outside of Pinewood in Sumter County and is operated by GSX Services of South Carolina, Laidlaw Environmental Services, Inc. The state also has two commercial hazardous waste thermal treatment facilities, incinerators, ThermalKEM, a fixed-hearth facility in Rock Hill, and Thermal Oxidation, (also Laidlaw Environmental Services, Inc.) a liquid injection system in Roebuck, outside Spartanburg.

Hazardous Waste Management

Percentages of total hazardous waste in the U.S.
Methods of treatment and disposal



4% RESOURCE RECOVERY
6% INCINERATION
8% PHYSICAL OR BIOLOGICAL PROCESSES
11% DEEP WELL INJECTION
33% CHEMICAL TREATMENT
38% LANDFILLED

CLOG-FREE
DRAIN CLEANER

Household Hazardous Wastes

According to experts, products may not be hazardous while they are being used, but they can become hazardous when they are burned, poured down the drain or disposed of improperly.

There is a difference between hazardous products and those that can become hazardous and are dangerous. For example, household bleach may seem harmless, but if mixed with ammonia, it creates toxic fumes. Batteries are harmless in appliances but are not welcome in landfills.

While businesses and manufacturers are carefully monitored, **there are no laws to regulate how households handle their hazardous wastes.** This is why it is so important that people understand the potential risks to health and the environment of the household hazardous products they may purchase, use and store.

According to the article "Horror in the Basement," *Recycling Today* magazine, August 1991, Americans are left to police their own contributions to the hazardous waste stream. The result is a jumble of state and community laws, random hazardous waste collections and hosts of opinions on how risky household chemicals are to human health.

People seem to agree on the facts, but clash on their perceptions of the problem. Industrialists want more recognition for developing less-toxic products; environmentalists frown on any toxins lining the store shelves. "Green" citizens are aghast when neighbors use products such as chemical drain cleaners; their neighbors, in turn, shrug at all the fuss made over the seemingly irreversible existence of chemicals in the household. Many environmentalists view hazardous waste landfills as bad; while others see them as good and necessary.

Household hazardous waste may contain the same hazardous components of industrial hazardous waste; but because of the small volumes, it is difficult to account for in state statistics.

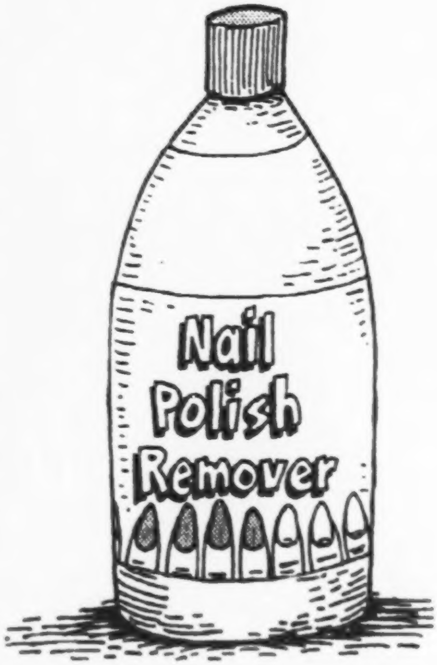
According to Environmental Health Watch in Cleveland, Ohio, each person may be responsible for generating 15 pounds of household hazardous waste each year.

In household hazardous waste collection programs, each household brings in an average of 100 pounds of these materials, according to WasteWatch, a national clearinghouse on household waste.

DHEC sponsors household hazardous waste collections at various times and has ongoing provisions for recycling used oil and lead-acid car batteries. Large commercial waste operators also sponsor household hazardous waste collections.

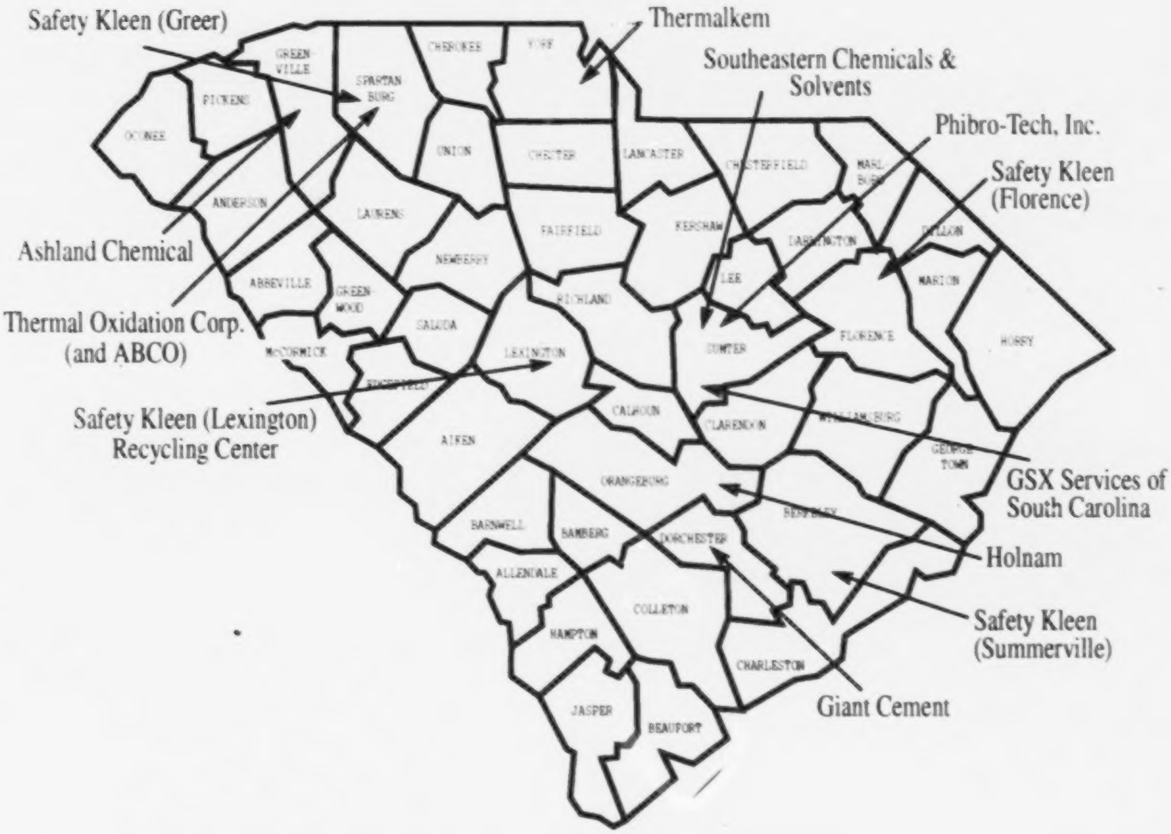
Examples of household hazardous waste include paint thinner, batteries, drain cleaners, poisons, pesticides, fertilizers and other cleaning and chemical-based products.

When used safely for their intended purpose, the vast majority of these products present few concerns. But when used improperly or when containers pile up in basements, garages and barns, they are dangerous. And if they get poured down the drain or put into the household trash, they can become a dangerous source of pollution.



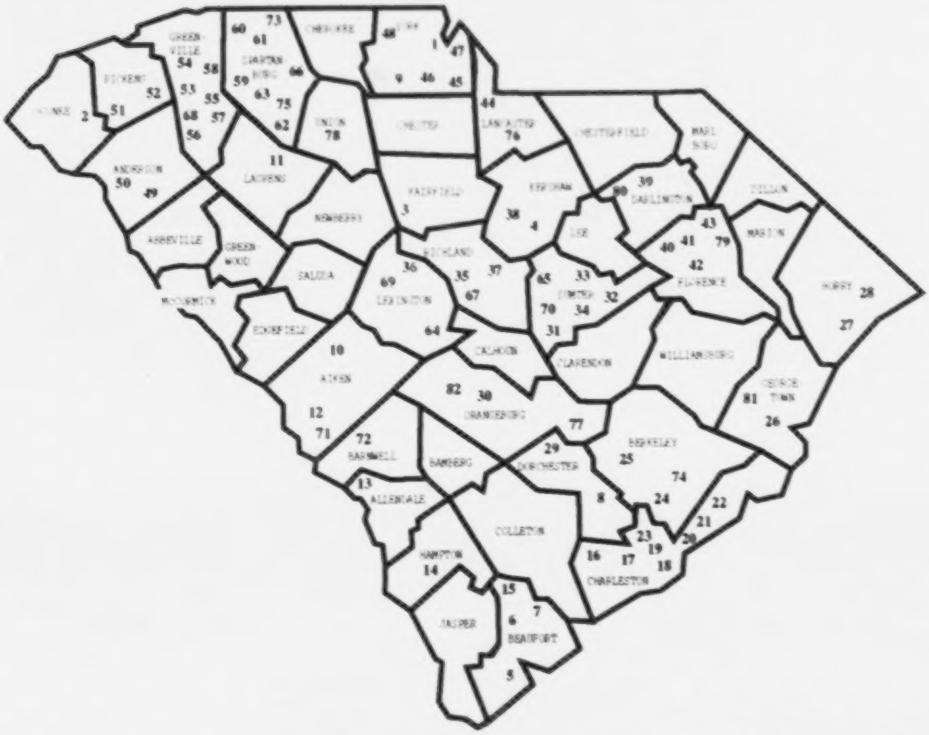
HOUSEHOLD HAZARDOUS WASTE MAY CONTAIN THE SAME HAZARDOUS COMPONENTS OF INDUSTRIAL HAZARDOUS WASTE; BUT BECAUSE OF THE SMALL VOLUMES, IT IS DIFFICULT TO ACCOUNT FOR IN STATE STATISTICS.

MAJOR HAZARDOUS WASTE COMMERCIAL OFF-SITE FACILITIES IN SOUTH CAROLINA, 1993


Safety Kleen (Greer)
Thermalkem
Southeastern Chemicals & Solvents
Phibro-Tech, Inc.
Safety Kleen (Florence)
Ashland Chemical
Thermal Oxidation Corp. (and ABCO)
Safety Kleen (Lexington) Recycling Center
GSX Services of South Carolina
Holnam
Safety Kleen (Summerville)
Giant Cement
OCONEE
PICKENS
GREENVILLE
SPARTANBURG
CHEROKEE
YORK
UNION
CHESTER
LANCASTER
CHESTERFIELD
MARLBORO
ANDERSON
LAURENS
FAIRFIELD
KERSHAW
DARLINGTON
DILLON
NEWBERRY
ABBEVILLE
GREENWOOD
LEE
MARION
SALUDA
RICHLAND
SUMTER
FLORENCE
HORRY
McCORMICK
EDGEFIELD
LEXINGTON
CALHOUN
CLARENDON
WILLIAMSBURG
AIKEN
GEORGETOWN
ORANGEBURG
BERKELEY
BARNWELL
BAMBERG
DORCHESTER
ALLENDALE
COLLETON
HAMPTON
CHARLESTON
JASPER
BEAUFORT

source: South Carolina Department of Health and Environmental Control, Office of Environmental Quality Control, Bureau of Solid and Hazardous Waste Management

Locations of South Carolina's Hazardous Waste Treatment, Storage, and Disposal (TSD) Facilities


OCONEE
2
PICKENS
51
52
GREEN-VILLE
54
53
58
55
68
57
56
60
73
61
SPARTAN-BURG
59
66
63
75
62
CHEROKEE
48
YORK
1
47
9
46
45
UNION
78
CHESTER
44
LANCASTER
76
CHESTERFIELD
MARLBORO
ANDERSON
50
49
11
LAURENS
FAIRFIELD
3
KERSHAW
38
4
80
39
DARLINGTON
DILLON
ABBEVILLE
GREEN-WOOD
NEWBERRY
LEE
43
40
41
79
42
FLORENCE
MARION
SALUDA
69
36
RICHLAND
35
37
67
LEXINGTON
65
33
SUMTER
32
70
34
31
HORRY
28
27
McCORMICK
EDGEFIELD
64
CALHOUN
CLARENDON
WILLIAMSBURG
10
AIKEN
82
30
ORANGEBURG
GEORGE-TOWN
81
26
12
71
72
BARNWELL
BAMBERG
77
29
DORCHESTER
BERKELEY
25
74
13
ALLENDALE
8
24
22
21
COLLETON
23
19
20
16
17
18
CHARLESTON
HAMPTON
14
15
7
6
JASPER
BEAUFORT
5

Key

1. Duke Power
2. Duke Power
3. SCE&G
4. Hardwicke Chemical
5. USMC Recruit Depot
6. NWL Controls
7. USMC Air Station
8. Safety-Kleen
9. Leonard Chemical Co., Inc.
10. FMC Corp. - Ground Systems
11. Torrington
12. SRS M. Area
13. Sandoz Martin Works
14. Westinghouse Electric Corp.
15. Le Creuset of America
16. Stoller II
17. Lockheed-Georgia
18. North Hand Protection
19. Moore Drums, Inc.
20. Medical University of S.C.
21. Albright & Wilson, Inc.
22. USN Chas. Weapons Station
23. USAFB Charleston
24. US Naval Shipyard Chas.
25. E.I. DuPont de Nemours
26. Georgetown Steel Corp./GE
27. USAF Myrtle Beach
28. Wol. Brass Works/D. Walthe
29. Giant Cement Co.
30. Cox Wood Preserving Co.
31. GSX Services of S.C.
32. SE Chemical & Solvents
33. Southern Coatings Inc.
34. C.P. Chemicals, Inc.
35. Owen Electric Steel Co.
36. Allied Corporation
37. USA Ft. JAckson ATC
38. E.I. DuPont de Nemours
39. Intl. Minerals & Chemical Co.
40. ESAB Welding Products, Inc.
41. General Electric Co.
42. Safety-Kleen
43. Koopers Company, Inc.
44. So. Screen Engravings, Inc.
45. Landfill, Inc.
46. Thermalkem, Inc.
47. Hoechst-Celanese
48. North Hand Protection
49. Owens Corning Fiberglass
50. Eliskim Inc.
51. BASF
52. Platt Saco Lowell Corp.
53. Carolina Plating Inc.
54. T&S Brass & Bronze Works
55. Steel Heddle Mfg. Co.
56. Roy Metal Finishing Co.
57. G.E. Gas Turbine
58. American Hoechst Corp.
59. Safety-Kleen
60. Milliken Chemical Dewey
61. Southern Wood Piedmont Co.
62. MEMC Elec. Materials, Inc.
63. Siemens Energy & Automtn.
64. Gaston Copper Recycling
65. USAFB Shaw
66. Blackman-Uhler Chem. Div.
67. Ashland Chemical Co.
68. Ashland Chemical Co.
69. Safety-Kleen
70. USAF Poinsett Range
71. SRS F. Area
72. SRS H. Area
73. Hudson Wire
74. Miles, Inc.
75. Laidlaw Environmental Ser.
76. Thomas & Betts, Inc.
77. Holnam
78. Torrington
79. DuPont
80. CP&L
81. VVV
82. Ethyl Corporation

A Closer Look at Composting

Composting is nature's recycling. The U.S. EPA includes composting in its definitions of **recycling**. In composting, the natural process of decomposition recycles organic material into a humus-rich soil amendment. Compost looks, feels and smells like soil.

In this country, approximately 30 percent of our household trash is yard clippings and kitchen scraps and as much as 70 percent of our trash is organic material that can be composted. If composted instead of thrown away, this waste would provide a useful resource instead of filling up our landfills.

When yard wastes are thrown away and taken to the landfill, the organic matter reacts with other materials and creates toxic leachate that may contaminate groundwater.

For areas that send their garbage to waste-to-energy facilities for incineration, yard waste is also problem. With its high moisture content, yard wastes reduce the efficiency of these operations.

Yard wastes and other trash should never be burned at home. Even if your community does not pick up yard waste for composting or disposal, do not burn it. Burning yard wastes causes air pollution from carbon dioxide and nitrogen oxide.

What To Do With Yard Wastes In South Carolina

In South Carolina, the Solid Waste Policy and Management Act forbids the disposal of yard waste and land-clearing debris in municipal solid waste landfills after May 27, 1993.

This means that yard trash must be handled separately from your household garbage. Do not put yard trash such as leaves, branches, or grass clippings in your trash can. These items should be kept separate for pick up. Communities will differ in how they pick up and handle and yard wastes.

Local governments can compost, shred for mulch or dispose of yard waste in a permitted construction, demolition and land-clearing debris landfill. **South Carolina has 60 registered composted/chipping facilities.**

No matter how your county handles yard wastes, yard wastes should not be mixed at the curb with other trash of any kind (no broken bricks, old wood, or other materials.)

The First Compost

Composting has been occurring naturally for millions of years ... as leaves fall from the trees to the forest floor and slowly decay.

The first recorded use of compost to improve the soil was organized by the Roman Statesman Marcus Cato more than 2,000 years ago. A scientist and farmer, Cato developed a formula for compost that would turn animal manures and vegetation into useful soil builders.

Today, we know that compost improves the soil structure, texture and aeration and increases its ability to hold water. Composting is an accelerated version of the natural decay process. Left to decay naturally, leaf waste can take approximately two years to form humus. In a compost pile, it can take as little as 14 days.

Compost loosens clay soils and helps sandy soils retain water. Adding compost to soils aids in erosion control, promotes soil fertility and helps keep plants healthy. In fact, compost can replace the need to use many fertilizers.

Three types of Composting

There are three types of composting.

1. **Nature's recycling** that occurs naturally on forest floors. This way nature replenishes itself and returns nutrients to plants and trees.
2. **Home/backyard composting** has been practiced by gardeners for years, turning garden and yard trimmings into a rich soil enhancer. Organic materials are usually collected in a pile or compost bin. Air, water and heat help break down materials into humus that's used for next year's planting.
3. **Municipal composting** is backyard composting on a much larger scale. Communities pick up yard wastes in special containers and compost it at large central facilities. Many communities sell the resulting compost to local gardeners and also use it for public parks, highway construction, land reclamation and other projects.

Composting: A Never-ending Solution

Unlike landfills that are reaching capacity, a composting site can be continually reused without reaching capacity. If properly managed, municipal composting is sanitary and produces no offensive odor problems.

Right now the biggest roadblock to composting is lack of awareness about the difference it can make in reducing our solid waste problems and lack of understanding about just how easy it is to start composting.

How the Compost Pile Grows

1. Where you live makes a difference in the best spot for your compost pile. In dry climates the best spot is under a tree. This keeps the pile moist and lets sunshine in part of the day. However it is best to avoid placing your compost pile under trees which produce acids that inhibit plant growth. In the south this means not placing your compost pile under a pine, eucalyptus, bay laurel, juniper, acacia, black walnut or cypress tree.

There are many different forms of composting. You will need to decide what materials you want to compost first before deciding on a composting bin. Select a composting bin that meets your needs or simply enclose an area with wire. (To make mulch from yard clippings you only need to designate a spot to spread out the material.)

2. Items suitable for composting include biodegradable organics such as grass clippings, leaves, wood chips, vegetable and fruit peelings and cores, coffee grounds and egg shells. Even used paper that can't be recycled (paper towels and napkins, paper plates and egg cartons) can be shredded and added. Since these items are not laminated they will break down completely. To prevent your pile from attracting pests do not compost meat scraps, bones, fish or dairy items.

3. Collect kitchen scraps in a small covered bin. Empty it into your pile every few days. Hardware and garden supply stores sell special bins for collecting kitchen scraps.

4. To speed the process of composting, chop, crush or shred all materials before adding them to your compost pile. Also spread out grass clippings and yard wastes.

5. Put new materials into the center of the pile where it is the hottest.

6. The temperature will rise as the materials begin to break down.

7. Turn the pile every few days with a pitch fork. The more you turn, the higher the oxygen level and the faster decomposition occurs.

8. Water the pile occasionally to moisten it, but do not over water.

9. In several weeks the compost will be ready. If you don't turn the pile, decomposition will take longer.

In colder months it may take longer to break down materials into humus.

For more information about composting, call your local Clemson Extension Service office.

Keep On the Grass
Bagging grass clippings is not necessary to maintain your lawn. New mulching mowers chop grass clippings and deposit them back in the grass to help fertilize the lawn. Grass clippings are 20 to 30 percent protein and usually contain about four percent nitrogen, two percent potassium and 0.05 percent phosphorus.

If you don't have a mulching mower, adjust you mower to remove no more than one-third of the grass surface at any one mowing.

How Much Time Will It Take?
The time it takes to prepare and maintain a compost pile for your yard wastes is about the same amount of time that it would take you to bag grass clippings and leaves, tie the bags, place them in trash cans and take them to the curb. If you compost kitchen scraps, add a few minutes.

How the Compost Pile Grows

Soil: contains microorganisms that help decomposition.

Organic Wastes: leaves, food scraps and grass clippings. Wastes should be varied including materials with high carbon and high nitrogen content. By alternating these materials you create good environmental conditions for decomposition.

Nitrogen: many of the organisms responsible for decomposition need nitrogen. Nitrogen is found naturally in many organic wastes, such as manure and green grass clippings.

Carbon: brown materials such as dead leaves, straw and saw dust.

Worms: they eat waste, helping to break it down. Worms make droppings that enrich the soil and tunnel through and aerate the waste. As the worms eventually die, they become part of the compost.

Water: necessary for normal functioning of life. Too much water in a compost pile may make it soggy and slow to decompose.

Air: the biological activity of fungi, bacteria, small insects and organisms results in decomposition. Most biological processes require oxygen.

Time: decomposition takes time. To speed it, aerate your compost pile every few days.

Heat: heat is produced by chemical reactions resulting from increased biological activity that occurs during decomposition. Heat helps sanitize compost by killing certain organisms such as weed seeds and harmful insect larvae.

Mass: to generate enough heat for optimal decomposition, the pile must contain at least one cubic meter of organic material. The temperatures generated in a small pile are different than those generated in one that is larger.

You can make a ton of compost at home in an area only 4 feet square.

A Formula For Success

There are many recipes for compost. The most important thing to remember is to balance nitrogen- and carbon-rich materials. No nitrogen means that the pile will not generate heat needed for rapid decomposition. One-quarter to one-half green (nitrogen) materials and one-half to three-quarters brown (carbon) materials will heat up and rapidly decompose.

Composting's Rs

Composting **reduces** the amount of trash you generate. You can **reuse** the compost in your yard. The compost **recycles** nutrients back into your soil and plant life. Increased plant growth helps to **restore** the health and beauty of our neighborhoods.

source: Backyard Composting
Harmonious Technologies

If your compost has too much green material and not enough brown, it may begin to give off an ammonia odor. This is easily corrected by adding brown material.

Compost is most active when the ratio of carbon to nitrogen is 30:1. For example the ratio of carbon to nitrogen in leaves is 60:1. Compost can be made from leaves alone, but if two parts grass clippings are mixed with one part leaves, the process will be faster and will result in a more fertile product.

A Closer Look At Landfills

Landfills are enormous holes in the ground where garbage is dumped and buried.

A majority of our solid waste is buried in what are known as **sanitary landfills**, specially designed areas that are lined and covered to prevent landfilled wastes from harming the environment.

According to the U.S. EPA, about 6,000 solid waste landfills operate in the United States. South Carolina has experienced major changes in the disposal of solid waste over the last several years. Until recently, almost every county owned and operated a landfill that was used for municipal solid waste. With the passage of new federal landfill laws, South Carolina is experiencing a dramatic decrease in the number of landfills owned and/or operated by individual local governments. Currently, South Carolina has about 39 municipal solid waste landfills. The state has only eight municipal solid waste landfills that are permitted and meet federal regulations.

As the number of municipal solid waste landfills continues to decrease, many counties will explore options to transport waste to disposal facilities outside their areas. Because of this, the number of transfer stations has increased to 21 stations.

South Carolina is also the site of one of the nation's 32 commercial hazardous waste landfills. The landfill, operated by GSX Services of South Carolina - Laidlaw Environmental, is located in Pinewood.

According to the 1993 South Carolina Solid Waste Management Annual Report, South Carolina disposed of 4.4 million tons of solid waste in municipal solid waste landfills and 1.3 million tons of solid waste in other landfills for a total of 5.7 million tons of landfilled waste in 1993. Also, 330,219 tons of solid waste were incinerated in solid waste combustion facilities.

From Your House to the Landfill

According to figures from the National Solid Wastes Management Association in their publication, *At A Glance*, approximately 8,000 municipalities and private trash haulers pick up our country's garbage using 140,000 refuse collection vehicles. At present, private refuse companies serve around 60 percent of all households and remove more than 90 percent of the nation's commercial refuse. Most of this waste is deposited in landfills. A fee is paid to the landfill operator based on how much trash a truck carries. This fee is called a tipping fee because the trucks lift their loads to tip them on the face of the landfill. As landfill construction, maintenance, and operation costs have increased, tipping fees have increased. South Carolina's average tipping fee is $16.33.
At the landfill waste materials are unloaded, spread out and compacted by bulldozers into waste cells. Daily, the waste is covered with earth.

Several layers of waste make up a landfill cell. A cell is typically one part soil to four parts waste. Cells are built side by side and on top of each other until the landfill is filled. When a cell is filled, it is closed by covering the layers of dirt and waste with a clay cap and packing it into a solid surface. Soil is then layered over the clay. When a landfill is completely filled, two to five feet of additional impermeable soil is placed over it; and grass, plants, and trees are planted on top. Completely closed landfills are monitored after they are closed and the land is available for other use. In South Carolina, Greenville Technical College is located on the site of a closed municipal landfill.

Nationally, the amount of waste going to landfills has decreased in the last few years from 84 to 76 percent of total wastes. In South Carolina, it is estimated that 60 percent of our wastes are landfilled. Even with current strategies to reduce waste, the U.S. EPA predicts that landfills will still be receiving about 50 percent of the waste stream by the year 2000. One reason landfills remain popular is that they are cheaper to operate per ton of waste than incinerators or recycling plants.

Too Much Trash and Not Enough Space

Many parts of the country are now facing shortages in landfill disposal capacity. The U.S. EPA estimates that, between 1978 and 1988, 70 percent of our country's landfills – 14,000 facilities – closed. By 1995, predictions are that half of the remaining landfills will reach capacity and close, leaving large volumes of refuse without local disposal options.

This situation is a result of many factors including:

- a 34 percent growth in population since 1960
- an increasing volume of waste generated per person – up 1 percent each year
- many old waste incinerators were forced to close because they did not meet the guidelines of the Clean Air Act
- few new landfills are being built.

New Regulations for Landfills

In addition to these factors, new U.S. EPA Subtitle D regulations (part of the Resource Conservation and Recovery Act, RCRA, initially passed in the 1970s and amended to provide strict regulations for landfills) are coming into effect.

New regulations require installing plastic and clay liners, collecting and treating liquids that settle to the bottom of landfills (leachate), monitoring groundwater and surface water for harmful chemicals and monitoring for methane gas.

These new regulations will force landfill operators to either upgrade their systems or cease operation.

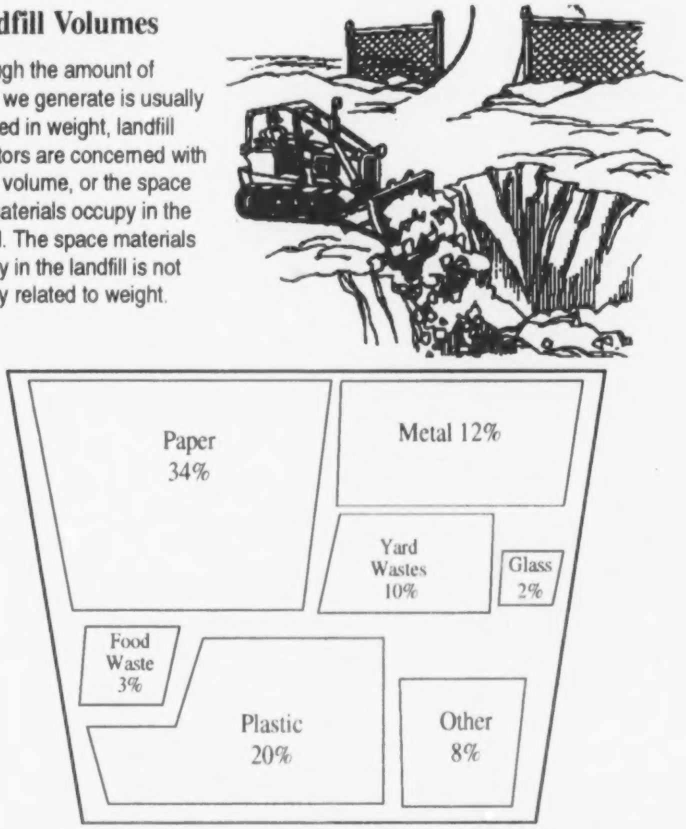
Estimated costs of building and maintaining a landfill that meets the new regulations are as much as $125 million, according to the *1993 Information Please Environmental Almanac*.

In South Carolina, all municipal solid waste landfills are required to meet the more stringent standards or close.

Several counties considered the financial commitment involved with the upgrade and decided to close their landfills and dispose of their solid waste at municipal landfills located in other counties. To reduce transportation costs to out-of-county landfills, many counties decided to construct transfer stations where solid waste is compacted prior to shipping.

Landfill Volumes

Although the amount of waste we generate is usually reported in weight, landfill operators are concerned with waste volume, or the space that materials occupy in the landfill. The space materials occupy in the landfill is not directly related to weight.



source: National Solid Wastes Management Association, *At A Glance* newsletter, 1991

The siting of new landfills is hampered by the environmental track record of dumps. More than 20 percent of the 1,200 cleanup sites on the Superfund National Priority List are old garbage dumps. These are sites where waste is polluting land and water resources. Some Superfund sites cost as much as $30 million to clean up.

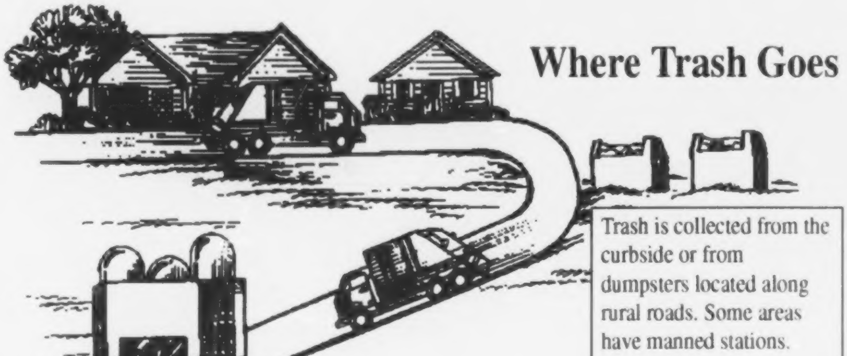
Modern landfills are designed to keep garbage in and keep pollutants from entering the environment. According to information presented in *The Garbage Primer* published by the League of Women Voters, landfills that meet federal standards lessen the environmental risk.

In addition to construction requirements, Subtitle D of RCRA requires landfill owners/operators to monitor water sources and to maintain a leachate collection system and a final cover (a 4-foot cap of soil or a combination of soil and synthetic material) for a minimum of 30 years after the landfill closes. This maintenance requirement is critical, since even the most well designed landfills may eventually deteriorate.

Gases generated from landfills are also an environmental concern. The primary gases emitted from landfills are carbon dioxide and methane. Methane is an odorless, explosive gas that is produced as organic matter decomposes under anaerobic (airless) conditions. Methane poses a health risk because it is explosive. Also it is a greenhouse gas and may contribute to global warming. Landfill gas also contains small quantities of other volatile organic compounds such as benzene and vinyl chloride. Methane monitoring is required under Subtitle D.

Leachate, the liquid that settles in landfills, can contain a broad range of chemicals, including lead, cadmium, and mercury. The amount of leachate generated by a landfill is influenced by precipitation, topography, facility design and

Where Trash Goes



Trash is collected from the curbside or from dumpsters located along rural roads. Some areas have manned stations.

Solid waste may be taken to centrally located transfer stations where the waste may be compacted or baled to reduce its size.

Municipal solid waste is disposed of in sanitary landfills that are carefully engineered to accept waste. These landfills must meet strict U.S. EPA guidelines.

Layers of the Landfill

Today's sanitary landfill is engineered to protect public health and the environment.

Subtitle D of the Resource Conservation and Recovery Act (RCRA) establishes standards that municipal landfills must meet.

Top Cap - The top cap of a landfill must be covered with:

- 2 ft. thick soil cover
- Drainage layer
- Flexible membrane layer of 60 mil HDPE plastic*
- 18" minimum clay liner (1×10^{-5} cm/sec max)
- Gas management layer

Waste Cells with operational cover

Bottom Liner - The landfill must have a protective bottom liner system that includes:

- 2 ft. protective layer of soil
- Leachate collection system
- Flexible membrane liner (60 mil HDPE plastic*)
- 2 ft. clay liner (1×10^{-7} cm/sec)

* Other materials may be substituted for HDPE plastic.

Note: For a full-color classroom poster, "The Anatomy of a Landfill," contact Santek Environmental, 1306 S. Lee Highway, Cleveland, Tennessee 37311, 1 800 467-9160.

operation, and the final vegetative cover. Landfills must install a groundwater monitoring system and set aside money to pay for any groundwater cleanup. A groundwater monitoring system consists of a series of wells located near the landfill that are sampled for the presence of contamination from the landfill.

A total of 400 million cubic yards of waste are landfilled in this country after recycling and combustion.

A Modern Landfill is No Dump

Well-engineered disposal facilities have little in common with the open dumps of the past.

Until recently, it was believed that waste decomposed completely in landfills. But studies of old landfills have proven that landfills – because of their liner systems and soil and clay covers – actually preserve garbage. In a landfill there is little if any air or sunlight, and things do not break down easily. Professor William Rathje of the Department of Anthropology at the University of Arizona examined waste buried in a landfill for 15 years or more and found newspaper you could still read and chicken bones with meat on them.

Our modern landfills do not permit much decomposition, therefore it is essential that the waste that can decompose, such as yard wastes, be disposed of in a system designed for biodegradation such as a compost pile.

How Garbage was Handled and Disposed in the Past

Trash disposal is an ancient problem that has typically been dealt with in the cheapest, quickest way. From the 1700s until the mid-1950s, communities relied on open burning and dumping as methods for solid waste disposal. Trash was disposed of in unpopulated areas considered unfit for development, such as river banks, wetlands, floodplains, marshes, swamps and bogs.

By the mid-1800s unsightly dumps were causing a number of health problems such as attracting rodents and other pests which transmit infectious diseases. As populations grew, so did refuse accumulation, and the question of what to do with household garbage went unanswered. By the late 1800s, some communities passed ordinances to clean up refuse areas, but there were no laws regulating manufacturing wastes.

At the turn of the century, most communities in the United States dumped their waste in marshes and wetlands. These areas were considered unsuitable for development and could be purchased at very low prices by local haulers and municipal governments. The prevailing belief was that the soil would act as a natural filter, and that as the waste residues percolated through the ground, the dilution process would render waste harmless.

No one anticipated the consequences of groundwater contamination and the effects on public and private water supplies of dumping trash.

Garbage dumps were frequently established in areas where supplies of fresh groundwater are "recharged" by rainfall, the same places where many municipalities were also locating drinking water pumps and wells.

In the 1930s much waste was burned in open pits to reduce its volume before burial. Open pit burning, however, caused its own problems and there were frequent landfill fires. First, surrounding neighborhoods lived with continuously smokey air. Second, the fire department always seemed enroute to put out landfill fires. In fact, landfill fires used to be so abundant that they were used by fire departments to train newly-enrolled firefighters.

As the need for disposal grew, the availability of marginal land for disposal decreased and many cities built incinerators, further reducing the need for land to bury garbage. With household garbage piling up, industrial wastes were also accumulating as the demand for new "convenience" consumer goods grew.

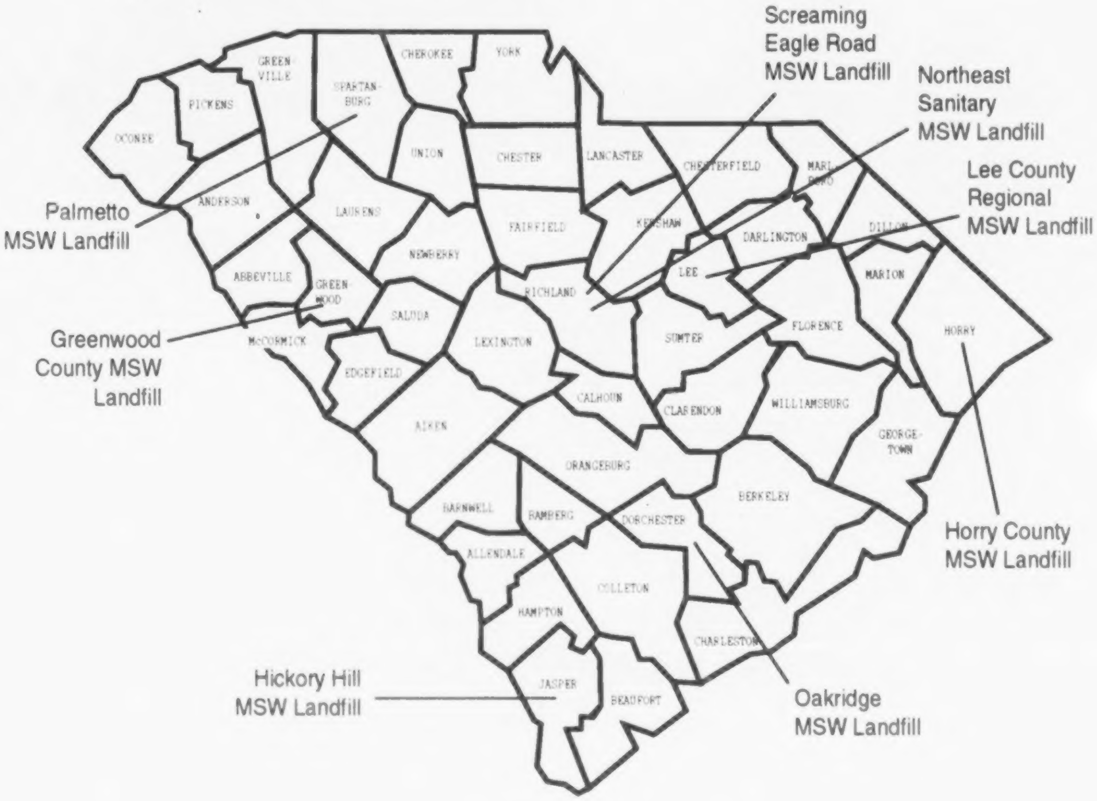
From 1900 to 1948 although the industrial revolution was in full swing, no significant environmental legislation was passed. By the time people learned that waste management of harmful industrial byproducts was needed, millions of tons of chemicals and other wastes had already been released into our air, water, and onto our land.

Public awareness of the importance of water and land-use preservation grew dramatically during the 1960s and 1970s.

In the 1970s the Resource Conservation and Recovery Act (RCRA) was passed. This was the first comprehensive legislation that dealt with landfills.

Today, landfills must be designed and operated under strict environmental guidelines administered by the U.S. EPA. In South Carolina, the Department of Health and Environmental Control enforces federal and state standards, devises programs to manage state-specific solid waste management, and issues operating permits to new and existing solid waste management operations. The South Carolina Solid Waste Policy and Management Act, signed May 27, 1991, establishes the policy of the state regarding solid waste.

SOUTH CAROLINA MUNICIPAL SOLID WASTE LANDFILLS THAT ARE PERMITTED AND MEET THE RCRA SUBTITLE D STANDARDS.


Screaming Eagle Road MSW Landfill
Northeast Sanitary MSW Landfill
Lee County Regional MSW Landfill
Palmetto MSW Landfill
Greenwood County MSW Landfill
Horry County MSW Landfill
Hickory Hill MSW Landfill
Oakridge MSW Landfill
OCONEE
PICKENS
GREENVILLE
SPARTANBURG
CHEROKEE
YORK
UNION
CHESTER
LANCASTER
CHESTERFIELD
MARLBORO
ANDERSON
LAURENS
FAIRFIELD
KERSHAW
DARLINGTON
DILLON
NEWBERRY
ABBEVILLE
GREENWOOD
RICHLAND
LEE
MARION
SALUDA
McCORMICK
EDGEFIELD
LEXINGTON
SUMTER
FLORENCE
HORRY
CALHOUN
CLARENDON
WILLIAMSBURG
AIKEN
ORANGEBURG
GEORGETOWN
BERKELEY
BARNWELL
BAMBERG
DORCHESTER
ALLENDALE
COLLETON
HAMPTON
CHARLESTON
JASPER
BEAUFORT

A Closer Look At Incineration

To incinerate means to burn to ashes. The burning takes place in a combustion chamber called an incinerator. A benefit of waste incineration is that, when wastes are burned, the resulting ashes take up less space in our landfills.

Although waste combustion is listed in the U.S. EPA's Integrated Waste Management strategy *before* landfilling, incineration is a waste management method that sparks controversy among scientists and citizens.

In South Carolina, incineration is not listed as a priority over landfilling. However, as counties develop their waste management plans, incineration is an option.

The History of Incineration

The first municipal incinerator, called "the destructor", was designed and built in England in 1874. It seemed to be a simple, efficient, and sanitary way to dispose of garbage.

Burning garbage eliminated the need for transporting waste from cities, saved space in dumps, and destroyed many disease-causing microorganisms and viruses. The technology was soon imported to this country, and the first garbage incinerator in the United States was built on Governor's Island, New York in 1885. By the 1920's there were more than 300 incinerators in use in this country.

The first incinerators burned trash without worrying about what was coming out of their smokestacks.

As concern rose over the quality of our air and legislation was introduced to prevent further air pollution, the cost of pollution control equipment made it cheaper to landfill waste and use of incinerators declined.

From Waste To Waste-to-Energy

Technology was developed to absorb some of the heat from waste incineration. Heat was used to turn water to steam which could be used to generate electricity. By producing energy, facilities became more cost effective. Burning wastes to produce energy is known as resource recovery, and the facilities are referred to as **waste-to-energy** plants.

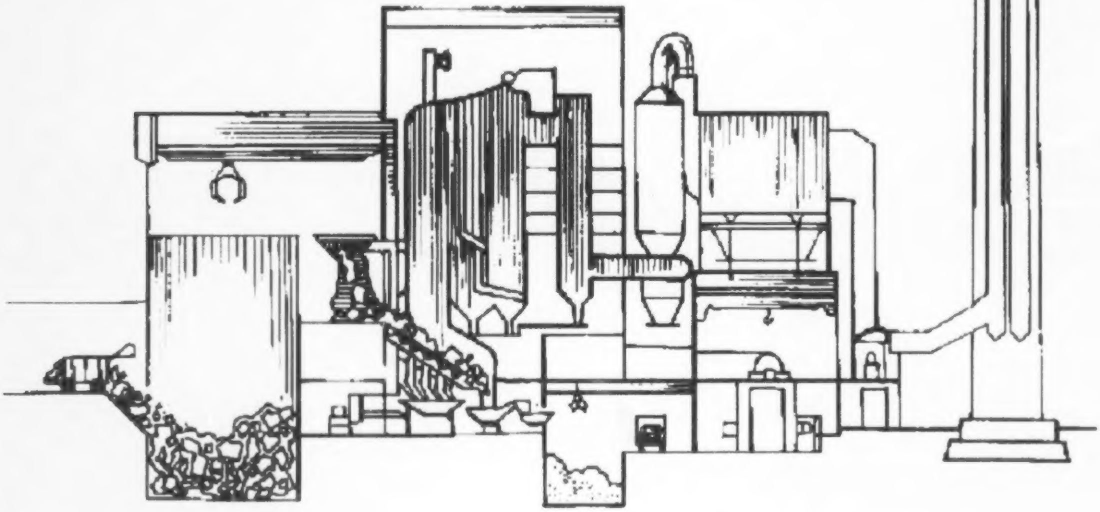
Burning wastes to produce energy lowered the temperature of incinerator exhaust to within temperatures where proven emission control equipment could operate effectively. Thus this technology made it possible to install pollution control equipment in incinerators. An incinerator's ability to generate electric power helped offset some of the high cost of installing this emission control equipment called **scrubbers**.

Today's waste-to-energy plants can reduce up to 90 percent of the volume of waste needing to be disposed and can be designed to process from 100 to over 3,000 tons of refuse daily. At the same time, these waste burning plants produce steam or electricity which can satisfy a portion of local energy needs.

There are currently more than 140 waste-to-energy plants operating in the United States. Of these, 64 are mass-burn facilities where mixed garbage burns in a single combustor and steam is generated which produces electricity; 49 are modular meaning they have two combustion chambers with a special chamber for destroying harmful gases, recover steam for energy, and are generally smaller than mass burn facilities; and 27 are refuse-derived fuel plants that burn materials that generate the most heat such as used oil.

South Carolina currently has two solid waste combustors permitted. They are in Charleston County and Hampton County. The state also has two hazardous waste incinerators, one in Roebuck and the other in Rock Hill.

Incinerating solid waste can reduce the volume of trash going to a landfill by up to 90 percent, resulting in a 60 to 70 percent reduction in landfill demand.



How Do Incinerators Work?

Incinerators burn waste to reduce its volume; that is, to make it smaller. Incinerators can burn unprocessed waste (mass burn) or processed waste (refuse-derived fuel). Incinerators can be equipped to generate energy by using the heat from burning garbage to turn water to steam, which is then either fed into a steam-loop (sometimes called a district heating system) or used to turn turbines installed at the incinerator plant to generate electricity.

Mass-burn facilities appear convenient from a solid waste management perspective. There is no pre-processing of waste, and no changes must be made in the way most municipalities collect their trash. When trucks enter a waste-to-energy facility, their loads are weighed, and the trash is delivered to a tipping platform. Front-end loaders and cranes are used to push the waste down a shoot (hopper), from where it is fed into the combustion chamber. The residual ash from the combustion chamber (bottom ash) and that collected by pollution control equipment (fly ash) is deposited into large covered dumpsters which are hauled away to a lined, specially permitted, sanitary landfill.

Incinerators require a steady flow of waste and need to maintain a steady temperature in burning. Non-combustibles in the waste stream such as glass and metal inhibit efficient burning as do kitchen wastes, leaves and grass because of their high moisture content (30-75 percent water) and low Btu (or heat released during combustion) value. Increasing amounts of petroleum-based plastic, with a high Btu value, in the waste stream also affect burning. To maintain a consistent temperature, incinerator operators must regulate a changing solid waste composition, the amount of trash fed into the plant, how the system is started up and shut down, and other variables that change burning temperatures.

What Are Some Of The Benefits Of Incinerators?

Incinerating solid waste can reduce the volume of trash going to a landfill by up to 90 percent, resulting in a 60 to 70 percent reduction overall in landfill demand. By doing, this incineration helps conserve land and protect water sources from contamination.

Incineration also destroys potentially disease-causing organisms in solid waste and helps keep them out of landfills. Incineration also destroys a number of chemicals and toxic compounds, such as pesticides, that are a major source of contamination at existing landfills. Dioxins are both created and destroyed in the incinerator combustion process, and some data indicate that resulting dioxin levels may be reduced overall from that found in incoming solid waste.

What Are Some of the Problems of Incinerators?

In weighing the benefits of incineration against the drawbacks, communities must look at the costs of controlling and monitoring pollutants from air emissions, the disposal of incinerator ash, and the financing and siting of facilities.

Also, incinerators share many of the problems of any waste management facility (such as landfills and recycling centers), including truck traffic and associated noise and litter. However, since operations take place within an enclosed structure at an incinerator, problems such as litter, odors and insect and rodent infestation are better controlled than at a landfill.

The byproducts of incineration, — ash, gases, and heat — can be collected and reused to a large extent. And while incineration is a highly efficient method of waste disposal, there is some concern over the remaining byproducts.

Although modern incinerators use sophisticated air pollution control technology, emissions must be carefully monitored and controlled. The U.S. EPA estimates that more than 95 - 99 percent of particulate and organic pollutants can be removed from air emissions if certain pollution prevention steps are followed.

Ash is a substantial byproduct of incinerated garbage. According to *The Garbage Primer from the League of Women Voters*, an incinerator that burns 1,000 tons of trash per day can generate between 200 and 250 tons of ash a day as a residue. The composition and toxicity of incinerator ash depends on the content of the waste burned and the efficiency of the combustion. Ash is disposed of in special landfills called ash monofills.

Incinerators are expensive to invest in, operate and maintain, making it most economical to build large plants so that costs-per-ton-of-waste accepted are lower. However, large sums of money must be borrowed to construct an incinerator, and whether the plant is running at half or full capacity, the agreed upon schedule of payments must be met. Therefore, although larger plants may be more economical, oversizing a plant can be very expensive and actually can create something of a "demand" for waste, something contrary to waste management goals. Facilities are perhaps best undersized but designed with space to add an additional incinerator unit should it be needed.

How Does Incinerator Pollution Control Equipment Work?

The Clean Air Act, passed in 1970, limits emission of seven major classes of pollutants: particulates, sulfur dioxide, carbon monoxide, ozone, hydrocarbons, nitrogen dioxide, and lead.

This legislation put an end to incinerators without pollution control devices, as well as routine uncontrolled burning at open dumps. Pollution control devices are now required on incinerators to remove particulates, acid gas, and toxic compounds created in burning solid waste. Any incinerator that operates in South Carolina will have to comply with strict air pollution control regulations for its exhaust.

Pollution control in a state-of-the-art incinerator consists of temperature controls, "dry" or "wet" "scrubbers," and "baghouses." To receive an operating permit in South Carolina, an incinerator must have all of these controls in place. Temperature controls must have efficient combustion between 1,500 to 1,800° F to eliminate most particulate matter. Second, exhaust gases are carefully "co-aired" or cooled to precipitate out any dangerous vaporizing metals, such as lead and mercury. "Scrubbers" then use reagents (like lime) to neutralize acid gases.

Finally a "baghouse," essentially a fine mesh filtering system which works something like a vacuum cleaner bag, strains out particulates (solid matter remaining including the precipitated metals) from the exhaust gases. Together these controls eliminate most, but not quite all, particulates and acid gases from incinerator emissions.

In South Carolina these emissions are continuously tested to see that all particulates and gases are within levels permitted by the U.S. EPA and South Carolina Department of Health and Environmental Control (DHEC).

What Happens To Incinerator Ash?

In most cases, both "bottom ash" from the combustion chamber and the generally more toxic "fly ash" collected by the "baghouse" are combined for disposal and sent to double-lined landfills. Ash is tested before transportation to check its potential for leaching metals in mixed solid waste landfills. Leachate is collected in pipes, located above the liners at the bottom of the landfill which empty into a holding tank the contents of which are then taken to a waste water treatment plant for final treatment.

What Is the Debate Over Incinerator Safety?

There is much public debate about the safety of incinerators concerning their emissions and disposal of their ash. Proponents of incineration maintain that the toxicity of emissions and ash are well within levels determined safe by state and federal regulators, and most often, in fact, are substantially below levels that should be of remote concern. They also point out that incineration may actually reduce the amount and leachability of toxic substances that would otherwise be landfilled. Opponents of incineration maintain that some potentially dangerous emissions or leachables are not tested for or regulated, and many of those that are regulated, are permitted at levels of exposure that have not been proven safe or are, at least, open to question. They also note that incinerators concentrate toxic materials in their ash, compounding the problems of landfills and any accidents in handling the ash.

The incinerator safety debate is one of whether it is safe to proceed with incinerating waste on the basis of what we know. Proponents say that, based on what we know scientifically about the potential risks of incineration and landfilling its ash, there appears to be no significant public health threat. Opponents say that despite some studies, we know too little about the effects of long-term, low-level exposure to some of the byproducts of incineration and that, until we know more, we should not take a chance with public health. In the last analysis, this debate becomes social rather than technical in nature: a question of faith in technology and the limits of human ability to intervene safely in the environment. Whether incinerators operate in a given community or not ultimately will be determined by political and economic factors.

What Is The Future Of Incineration?

Although influential groups such as banks and construction companies may strongly support constructing incinerators, once constructed the uncertainties of future government regulation and vocal opposition as well as legal challenges to any incinerator have the potential to increase the cost to its investors and users. Regulation may affect both the ability of a plant to operate at full capacity (and therefore, economically) and may increase the cost of disposing of its ash (for example, if ash were to be classified as hazardous waste, as is sought by some). Although revenues from power generation may in part offset a fraction of incinerator costs, these revenues have proved quite variable as utilities have negotiated and public service boards determined the rate that an incinerator receives for its power. Like other waste management options, incinerators will be successfully operated only to the extent that they avoid the costs of alternate disposal means and associated environmental problems.

Finally, incinerators can be only as safe as the waste that is fed into them … wastes that society produces. Whatever other safety problems there may be, incinerators and their ash will be safest if nothing toxic (for example, batteries), nothing recyclable (metals, plastics, glass, paper) and nothing that can be composted (food and yard waste) goes into them.

An incinerator burning only mixed waste without toxics, recyclables, or compostable materials, will minimize any potential burning, pollution control and mechanical problems of incinerator technology.

Sources: *Wastewise;* Pollack, 1987; Natural Resources Defense Council, March 1988; *South Carolina Solid Waste Management Plan 1992 and 1993; 1993 and 1994 Information Please Environmental Almanac*

More on incineration ...
Japan incinerates about 34 percent of its waste, compared to 10 to 14 percent in the United States.

Japan has built over 1,900 incinerators in the last 25 years.

According to the National Solid Wastes Management Association, creating energy from garbage is a much cleaner process than using traditional fuels such as coal.

By the end of 1991, there were 140 energy-recovery or waste-to-energy facilities operating in the United States with a combined capacity of 94,000 tons per day.

It is estimated that if all the energy-recovery facilities currently planned come on line, 24 percent of the nation's municipal solid waste will be incinerated in the year 2000.

Plastics have the highest stored energy value of all materials commonly found in the waste stream. HDPE plastic generates 18,700 Btu per pound compared to 20,900 Btu per pound generated by fuel oil and 9,600 Btu generated by Wyoming Coal.

Among the states with the highest capacity for burning trash are Massachusetts (9,700 tons per day) and Pennsylvania (7,000 tons per day).

If the energy could be captured from all the wood and paper that Americans throw away each year, 40 million homes could be heated for 25 years.

Building new waste combustion facilities is expensive ... around $100 million for an averaged sized plant with the capacity of 1,000 tons per day.

The Foster Wheeler waste-to-energy plant in Charleston County receives approximately 225,000 tons of solid waste annually. Electricity generated on site is sold to Carolina Power & Light.

Chambers Medical Technologies owns and operates a waste-to-energy incinerator in Hampton County that receives about 68,000 tons of solid waste annually. The facility has a heat recovery system that produces steam. The plant handles most of the solid waste generated in Bamberg, Colleton and Hampton counties and other wastes generated by industries including medical wastes.

A Closer Look at Air Pollution

Air pollution is dangerous to the health of humans and other things living on Earth. Although it is often invisible, air pollution knows no boundaries. It creates smog and acid rain, causes cancer or other serious health effects, diminishes the protective ozone layer in the upper atmosphere, and contributes to the potential for world climate change.

Smog and other types of air pollution can lead to or aggravate respiratory, heart, and other health problems. It can be particularly harmful to people with existing lung or heart disease, the elderly, and the very young.

According to the U.S. Environmental Protection Agency, **six of every ten Americans live in areas that fail to meet one or more federal air quality standards during some portion of the year**. However, not everyone who lives in such areas will have health problems. Many factors play a significant role in determining whether or not someone will experience pollution-related health problems. These factors include level, extent, and duration of exposure, as well as the age and susceptibility of individuals exposed to air pollution. Since polluted air can move from one area or region to another, it has the potential to affect all of us.

Acid rain — caused by sulfur dioxide and nitrogen oxides combining with moisture in the air — limits the ability of lakes to support aquatic life. It may also damage trees and plants, and erodes building surfaces and national monuments. Pollutants in the air can also reduce visibility, obscuring the majestic vistas in national parks such as the Grand Canyon and the Shenandoah Valley.

Other air pollutants — known as "air toxics" — are known or suspected to cause cancer or other serious heath problems, such as damage to respiratory or nervous systems. Air toxics include metals, particles, and certain vapors from fuels and other sources.

Some chemicals used in refrigerators and air conditioners last a long time if released into the air, rising to the upper atmosphere where they destroy the protective ozone layer. These and other air pollutants (like methane and carbon dioxide) also contribute to the suspected accelerated warming of the earth, known as the "greenhouse effect."

Air pollution comes from many places. Some, like industrial smokestacks, chemical plants, automobiles, trucks, and buses, are well known. Others, like gas stations, dry-cleaners, outboard motors, lawn, garden, farm, and construction equipment engines; certain paints; and various household products, are not so obvious.

Here are the major pollutants, their sources, and their potential effects.

Ozone: A colorless gas that is the major constituent of photochemical smog at the earth's surface. In the upper atmosphere (stratosphere), however, ozone is beneficial, protecting us from the sun's harmful rays.

Ozone is formed in the lower atmosphere as a result of chemical reactions between oxygen, volatile organic compounds (VOCs) and nitrogen oxides in the presence of sunlight, especially during hot weather. Smog – formed by the reaction of these chemicals with sunlight – is called photochemical smog. Sources of these harmful pollutants include vehicles, factories, landfills, industrial solvents, and numerous small sources such as gas stations, farm and lawn equipment, etc.

Ozone causes significant health and environmental problems here at the earth's surface. It can irritate the respiratory tract, produce impaired lung function such as inability to take a deep breath, and cause throat irritation, chest pain, coughing, lung inflammation, and possible susceptibility to lung infection. Components of smog may aggravate existing respiratory conditions such as asthma. It can also reduce yield of agricultural crops and injure forests and other vegetation. Ozone is the most injurious pollutant to plant life.

Carbon Monoxide: Odorless and colorless gas found in the exhaust of motor vehicles and other kinds of internal combustion engines where fossil fuels are not completely consumed.

Automobiles, buses, trucks, small engines, and some industrial processes produce carbon monoxide. High concentrations can be found in confined spaces like parking garages, poorly ventilated tunnels, or along roadsides during periods of heavy traffic.

Carbon monoxide reduces the ability of blood to deliver oxygen to vital tissues, affecting primarily the cardiovascular and nervous systems. Lower concentrations have been shown to affect individuals with heart disease (for example: angina) and to decrease maximal exercise performance in young, healthy people. Higher concentrations can cause symptoms such as dizziness, headaches, and fatigue. In enclosed spaces, high concentrations can cause death.

Nitrogen Dioxide: Light brown gas at lower concentrations; in higher concentrations it becomes an significant component of unpleasant-looking brown urban haze. It is the result of burning fuels in utility plants, industrial boilers, cars, and trucks.

One of the major pollutants that causes smog and acid rain, nitrogen dioxide can harm humans and vegetation when concentrations are sufficiently high. In children, it may cause increased respiratory illness such as chest colds and coughing with phlegm. For asthmatics, it can cause increased breathing difficulty.

Particulate Matter: Solid matter or liquid droplets from smoke, dust, fly ash, and condensing vapors that can be suspended in the air for long periods of time. Particulate matter comes from industrial processes, smelters, automobiles, burning industrial fuels, woodsmoke. dust from paved and unpaved roads, construction, and agricultural ground breaking.

These microscopic particles can affect breathing and the respiratory sytem, causing increased respiratory disease and lung damage and possibly premature death. Children, the elderly, and people suffering from heart or lung disease (such as asthma) are especially at risk.

Particulate matter also damages paint, soils clothing, and reduces visibility.

Sulfur Dioxide: Colorless gas, odorless at low concentrations but pungent at very high concentrations. It is emitted largely from industrial, institutional, utility, and apartment-house furnaces and boilers, as well as petroleum refineries, smelters, paper mills, and chemical plants.

Sulfur dioxide is one of the major pollutants that causes smog. At high concentrations, it can also affect human health, especially among asthmatics who are particularly sensitive to respiratory tract problems and breathing difficulties that sulfur dioxide can induce.

Sulfur dioxide can also harm vegetation and metals. The pollutants it produces can impair visibility and acidify lakes and streams.

Lead: Lead and lead compounds can adversely affect human health through either ingestion of lead-contaminated soil, dust, paint, etc., or direct inhalation. This is particularly a risk for young children, whose normal hand-to-mouth activities can result in greater ingestion of lead-contaminated soils and dusts. Lead comes from transportation sources using fuels containing lead, coal combustion, smelters, car battery/plants, and combustion of garbage containing lead products. As of December 31, 1995, South Carolina does not allow lead in any gasolines sold.

Elevated lead levels can adversely affect mental development and performance, kidney function, and blood chemistry. Young children are particularly at risk due to their greater chance of ingesting lead and the increased sensitivity of young tissues and organs to lead.

Toxic Air Pollutants: Pollutants such as arsenic, asbestos, and benzene. Toxic air pollutants often come from chemical plants, industrial processes, motor vehicle emissions and fuels, and building materials.

They are known or are suspected to cause cancer, respiratory problems, birth defects, and reproductive and other serious health effects. Some can cause death or serious injury if accidentally released in large amounts.

Stratospheric Ozone Depleters: Chemicals such as chlorofluorocarbons (CFCs), halons, carbon tetrachloride, and methyl chloroform that are used in refrigerants and other industrial processes. These chemicals last a long time in the air, rising to the upper atmosphere where they destroy the protective ozone layer that screens out harmful ultraviolet (UV) radiation before it reaches the earth's surface.

These ozone depleters result from industrial and household refrigeration chemicals, cooling and cleaning processes, car and home air conditioners, some fire extinguishers, and plastic foam products.

Increased exposure to UV radiation could potentially cause an increase in skin cancer, increased cataract cases, suppression of the human immune response system, and environmental damage.

Greenhouse Gases: Gases that build up in the atmosphere that may induce global climate change — or the "greenhouse effect." They include carbon dioxide and methane.

The main man-made source of carbon dioxide emissions is fossil fuel combustion for energy-use and transportation. Methane comes from landfills, cud-chewing livestock, coal mines, and rice paddies. Nitrous oxide results from industrial processes such as nylon fabrication.

The extent of the effects of climate change on human health and the environment is still uncertain, but could include increased global temperature, increased severity and frequency of storms and other "weather extremes," melting of the polar ice cap, and sea-level rise.

What can we do at home and at school to prevent air pollution?

- **Conserve electricity.** Generating electricity can be a major source of air pollution. New home- and office-oriented technology can help. At home or work you can save electricity by using energy-efficient lighting wherever possible. Make sure that lights and appliances are turned off when not in use. In addition, you should raise the temperature level on your air conditioner a few degrees in summer, and turn down your heat a few degrees in winter.

Purchasing energy-efficient appliances will also aid in conserving energy use. Conserving electricity reduces air pollution caused by power plants.

- **Buy fuel-efficient motorized equipment.** If you are buying a power mower or other motorized garden tools, construction or farm equipment, or outboard motors, seek out those that are designed to minimize emissions and reduce spillage when being refueled.

- **Avoid spilling gas.** Take special care to avoid spills and the release of fumes into the air when refueling gasoline-powered lawn, garden, farm and construction equipment, and boats.

- **Properly dispose of household paints, solvents, and pesticides.** Do not pour these chemicals down the drain, into the ground, or put them into the garbage. Call S.C.DHEC at 1 800 So USE IT for information on proper disposal of these products.

- **Seal containers tightly.** Make sure that containers of household cleaners, workshop chemicals and solvents, and garden chemicals are tightly sealed to prevent volatile chemicals from evaporating into the air. Don't leave containers standing open when not in use.

- **Reduce waste.** When you make purchases, consider using products that are durable, reusable, or that use less packaging. Repair broken items rather than buying new ones. Recycle and compost potential wastes before they become part of the waste stream. Such actions help reduce the pollutants that might reach the air during the manufacturing process or during the collection and processing of wastes for incineration or landfill disposal.

- **Use wood stoves and fireplaces wisely and sparingly.** If you have a wood stove, learn how to burn cleanly and more efficiently. Remember to burn dry, well-seasoned wood, and build efficient fires that burn hot and clean. Check your stack, clean your chimney, and inspect your catalyst annually. A well maintained and operated stove produces less pollution and is better for the environment.

- **Properly dispose of refrigeration and air conditioning equipment.** The U.S. Clean Air Act prohibits the release into the atmosphere of refrigerants from automobiles and home appliances during the disposal of this equipment. Contact your local government or trash pickup service to find out what procedures there are in your area to ensure the safe disposal of cars and home appliances. In some areas, municipalities arrange for periodic pickups of home appliances that contain refrigerant. In others, it is required that homeowners have the refrigerant removed by a qualified service technician before the appliance can be picked up. If you have any questions, contact S.C.DHEC at 1-800-SO-USE-IT for more information.

- **Recycle refrigerant.** As of July 1, 1992, individuals are prohibited from knowingly venting refrigerant into the atmosphere while maintaining, servicing, repairing, or disposing of air conditioning or refrigeration equipment. Make sure the technician who services, repairs, or maintains your refrigerator or air conditioner has recovery equipment to capture any refrigerant that may be released. This refrigerant can later be recycled. Also, when possible, don't just refill leaky air conditioning or refrigeration systems — repair them.

A Closer Look at Water

There are nine planets in space circling the sun. These nine planets make up our solar system. Each planet has unique qualities because of its orbital position as it travels around the sun. As far as scientists are aware, only one of these nine planets has ever sustained what we know as life.

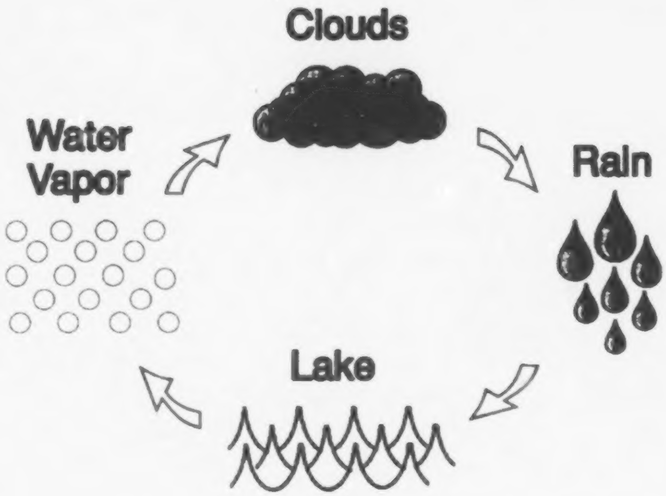
From out in space the planet Mars appears red, Venus is shrouded in dense clouds, and Earth is a distinct blue swirled with white cloud bands.

The "blueness" tells us something important about the characteristics of planet Earth. This planet is the *water* planet.

The fact that this is the only planet that sustains life, also tells scientists something important about water and life. Water is crucially important to life on Earth. Human bodies are over two-thirds water. Many animals such as the jellyfish contain an even higher amount of water. Humans can go for many days without food, but only a few without water. No organism survives without water in some form.

The compound water is a simple one. Two hydrogens and one oxygen combine to make water. Water is also an interesting molecule. It is one of only a few compounds which can exist in solid, liquid, and gaseous states of matter under normal, seasonal, climatic conditions. Water is also a unique compound because as it changes from a cold liquid to a solid, it becomes *less* dense. Ice cubes and icebergs float! Think about what Earth would be like if lakes and oceans froze solid all the way to the bottom over the winter. Water is also a universal solvent, easily dissolving many of the substances it comes in contact with. As it flows over the Earth's surface, water is constantly wearing away and changing the surface of the planet.

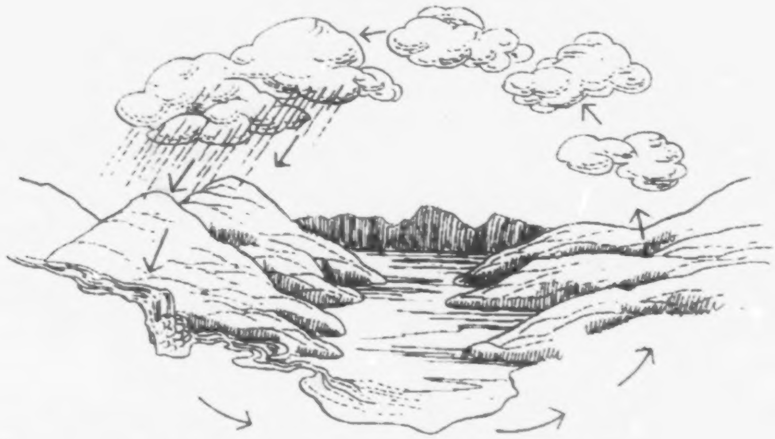
If Earth's water was quickly consumed by its life forms and once used up was forever gone from the planet, Earth would soon look very much like some of the other planets in our solar system. However, on planet Earth, water is constantly moved in a large circular pattern or cycle so that it is never used up.



The sun heats surface water causing water to change from a liquid state to its gaseous state. The water vapor rises above the Earth until it reaches a height where it becomes cooled and clouds of water droplets are formed. As the clouds build, rain and other forms of precipitation return the water back to the Earth's surface where it runs off into lakes, streams, and the ocean or soaks down to become ground water. This great cycling of water does not mean that there is an endless supply. Because of water's capacity to dissolve, it can quickly become dirty and unfit for life forms to use.

The entire water cycle can be observed in South Carolina on a hot summer day. In the morning the sky is a clear blue. As the day goes on, the sun heats the Earth's surface and water is evaporated from rivers, lakes, and the ocean. Trees also give off water in a process called *transpiration*. This water vapor rises into the atmosphere. As the water vapor moves higher in the atmosphere, it reaches an area where cooler temperatures cause condensation to occur. The droplets formed during condensation gradually come together as puffy cumulus clouds. As the afternoon passes, the hot sun continues to heat surface water creating more water vapor which then rises and condenses into more clouds above the earth. By mid afternoon, the sky is no longer a clear blue, but is filled with clouds. By late afternoon, these clouds may join together and build into dark rain clouds. A short thunderstorm later, the water returns to the Earth's surface as a summer rain shower.

The Hydrologic Cycle



As the water moves through the hydrologic cycle, it changes the appearance of Earth via the friction of liquid water moving over rock and soils. Mountains are worn away and lakes are filled with sediment as water continues its passage from the atmosphere to the oceans and back. Some of the shape of South Carolina is due to water flowing from the southern Appalachian Mountains toward the Atlantic Ocean.

Water that soaks down below the surface may not return to the cycle as quickly and may remain underground for many years. As the water moves through the hydrologic cycle, it changes the appearance of the planet Earth via the friction of liquid water moving over rock and soils. Mountains are worn away and lakes are filled with sediment as water continues its passage from the atmosphere to the oceans and back. Some of the shape of South Carolina is due to water flowing from the southern Appalachian Mountains toward the Atlantic Ocean.

From space, the blue oceans are the dominate feature of Earth. It would seem that there is more than enough water for every living thing. However, most organisms need water in a much purer form than that found in the oceans. Most animals and plants need FRESH water. Parts of the Earth are rich in fresh water streams, rivers, and lakes. South Carolina has many surface water bodies. The Savannah, Broad, and Catawba Rivers drain water from the mountains into the Atlantic Ocean. South Carolina's landscape is dotted with many large natural and man-made lakes.

The Earth also contains another source of fresh water located down in the ground. These stores of fresh water, known as groundwater, can be accessed by wells to supply drinking water to a large portion of the human population.

In South Carolina, 60 percent of the population gets its drinking water from groundwater. The groundwater is constantly replenished by precipitation that soaks deep into the ground. The groundwater flows very slowly towards the oceans and can be easily contaminated by pollutants that seep down from spills on the surface. Once contaminated, groundwater is very difficult to clean.

The rapid growth of Savannah, Georgia has created a high demand on its underlying groundwater. When groundwater is removed from its aquifer faster than it can be recharged from above, several problems can occur. Not only is there less water at Savannah but now, at nearby Hilton Head Island, so much groundwater has been removed to serve Savannah's needs that salt water from the ocean is moving in to fill the spaces where groundwater was stored. As a result, many wells on Hilton Head Island now contain water that is slightly salty.

Since the earliest times, humans have used water from lakes and rivers to drink, cook, and wash. Flowing water has also been used to get rid of wastes. In dry areas, shallow wells have been dug to supply fresh water. As more and more humans used water for a multitude of purposes, disease organisms also adapted to use this route to pass from human to human. Cholera and typhoid killed many and made large numbers of people very ill. In more modern times, industry used water for various purposes, often returning it back to its source in a polluted state. Others used water to dump wastes, using the natural flow to carry these "bad things" away from their homes. Unfortunately, someone else lived downstream and then had no clean water to use.

The ancient Chinese knew that when consumed, some water could make humans sick. Early writings indicate that boiling water made it safer to drink. The Greeks knew to filter water through cloth to remove impurities. In modern times, we know that water directly from its source is often not suitable to drink. This water must be cleaned and purified using much the same methods as ancient cultures.

Today, all drinking water from a public water source (not a private homeowner well) is carefully treated and monitored to ensure that the safest product flows from your tap. Source water passes through a Water Treatment Plant where the water is filtered and cleaned of microorganisms using a variety of disinfectants. It is then sent through underground pipes directly into the home. The amount of water each home uses is metered and a water bill is derived. People in advanced cultures no longer need to carry buckets of water daily from a community well.

Since outbreaks of waterborne diseases are fairly rare in civilized parts of the world, people tend to take clean drinking water for granted. The water bill comes each month and people often wonder, "Why do I have to pay for such an abundant resource?" Providing clean, safe water to homes, work and school is a big challenge. Treatment plants must constantly upgrade their facilities to the latest technologies as source water becomes increasingly polluted. The more polluted the source water is, the more processes it must go through at the Water Treatment Plant to be safe for human consumption. The many challenges to providing safe drinking water to the public require a constant vigilance by federal, state, local agencies, and the water treatment industry.

Lastly, if the blue planet Earth's abundant water is constantly cycled over and over, then there would seem to be no need to practice conservation measures. Earth contains about the same amount of water as it always has. But once this water becomes contaminated, it becomes less useable. Groundwater that is poisoned by gasoline leaking from underground storage tanks is not fit to drink. Lake water that is contaminated by runoff full of fertilizers and pesticides from lawns and gardens also is less useable. When too much water is pumped from wells, the underlying aquifer is emptied. In coastal areas the aquifer's fresh water stores can become mixed with salt water. And water that is uselessly poured down the drain while washing dishes, brushing teeth or taking a shower eventually makes its way into the oceans where it becomes salt water. As the population of humans on the planet and their ensuing demand for water grows, while more and more water is polluted and wasted, some form of water conservation will be necessary. Hopefully, people will be wise enough to protect this precious resource while they still can.

A Closer Look At Energy

excerpts from the *Energy FactBook, a resource for South Carolina* produced by the State Energy Office

WHAT IS ENERGY?

Energy is what makes things work. When we flip on a light switch, we use energy. We use energy riding a bus to school. Listening to a favorite song on a CD player uses energy. Try to imagine a world without energy. There would be no TV, no computers and no cars. Energy is what makes our lives comfortable and prosperous.

WHERE DOES ENERGY COME FROM?

A major source of energy is the sun. The sun's light and heat are both forms of energy. Plants use the sun's energy to grow. When we eat plants, we take in their energy This gives us the energy to think and learn.

The wind and sea are energy sources. So too are oil, coal, natural gas and wood.

ENERGY'S ROLE IN HISTORY

Because energy is basic to our lives, it is at the very heart of civilization. Prehistoric people learned to use fire's heat energy. They used it to take away the night's chill, to cook food and to fashion tools.

The ancient Egyptians discovered there was energy in wind. They used it to sail their ships. By the first century B.C., people learned to use the energy power of water. The waterwheel harnessed the energy of moving water. Water power was stronger than the muscle power of both people and animals combined.

The principle behind the waterwheel was also applied to the wind. Windmills popped up in the lowlands of Europe. Using only the wind for power, windmills ground grains into flour. In areas far from the seas, wind power became an important energy resource. By the 1800's, civilization searched for more energy resources. People, work animals (such as horses and oxen) and wood were no longer enough. While water and wind power continued to fill many energy needs, they were unreliable.

The answer to this quest came in the form of James Watt's invention of the steam engine. Steam took industry indoors. Workers left their rural homes for work in big city factories. The Industrial Revolution pushed civilization "full steam" ahead.

Other energy inventions followed. One exciting idea seemed to spark another. Work by physicists in Europe and experiments by Thomas Edison in New Jersey led to the invention of the light bulb in 1879. By 1882, New York's Pearl Street generator was routinely sending electricity into homes.

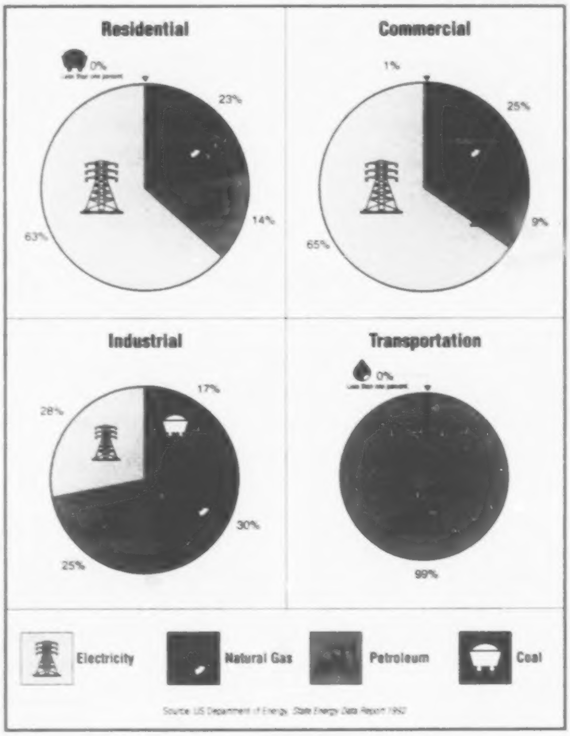
Electricity-Generating Plants in South Carolina

OUR CHANGING ENERGY NEEDS

Inventions and industrialization also changed our energy needs. In Colonial times, wood was the chief fuel used in the U.S. By the 1850's, wood was still filling 90% of our energy requirements. Coal was also becoming an important fuel, since it powered the steam engines that ran factories.

All of this changed in 1859 with the invention of the internal combustion engine. The gasoline-driven internal combustion engine became the foundation for the "horseless carriage." Cars transformed American society forever. Their huge popularity made gasoline the driving energy force in our economy.

For the first two-thirds of the 20th century, America was the undisputed technological king of the world. Our prospering economy, even after two World Wars, was built on our many energy resources. We consumed petroleum, natural gas, coal, and wood with confidence that these resources would not run out. Nuclear energy also became an important resource. Americans were unmatched in their ability to use energy of all types. By 1970, the 210 million citizens of the U.S. used more energy for air conditioning than the 800 million citizens of China used to fill all of their energy needs!



Source: US Department of Energy, State Energy Data Report 1992

THE OIL CRISIS OF 1973

Then came the Oil Crisis of 1973. Politics suddenly controlled energy resources. Because the U.S. politically supported Israel, the oil-rich Arab countries stopped selling us oil. Everyone felt the impact of the oil shortage. Airlines cut back on flights. Vacations were canceled. Administrators thought about shortening the school year. Workers lost jobs. For the first time, people stopped taking energy for granted.

OUR ENERGY FUTURE

Fortunately, that Crisis ended in 1974. Perhaps even more fortunately, we learned important lessons. We now know our energy supplies are not limitless. Petroleum, in particular, may not always be plentiful and inexpensive.

In response, we have developed technologies that make better use of our resources. Appliances and homes have become more energy efficient. Scientists have also looked to untapped resources as alternative energy sources, like the use of waste products for fuels.

The Oil Crisis taught us to rethink the way we use energy. While energy use is still considered a sign of progress, energy waste is now regarded as both shortsighted and thoughtless. Through conservation, we can lessen our dependence on foreign suppliers of energy, and prolong the life of those resources we have. Energy is something we must think about today and plan for tomorrow. It concerns us all.

ENERGY USE

Energy analysts commonly think about energy use in terms of groups or sectors of the economy – the residential, commercial, industrial and transportation sectors.

The **residential sector** refers to private home usage of energy. "Homes" include single and attached family houses and townhouses, apartments, farmhouses and mobile homes. In this sector, people use energy for heating and cooling homes, and running appliances.

Schools, hospitals, hotels and motels, movie theaters, and offices make up the **commercial sector**. Here, people use energy for heating and cooling as well as running business equipment such as computers and cash registers.

Manufacturers, miners, farmers, foresters and fisherman together form the **industrial sector**. Their energy needs are usually large, but can be quite small. They center on operating the machinery that runs our nation's factories and mills.

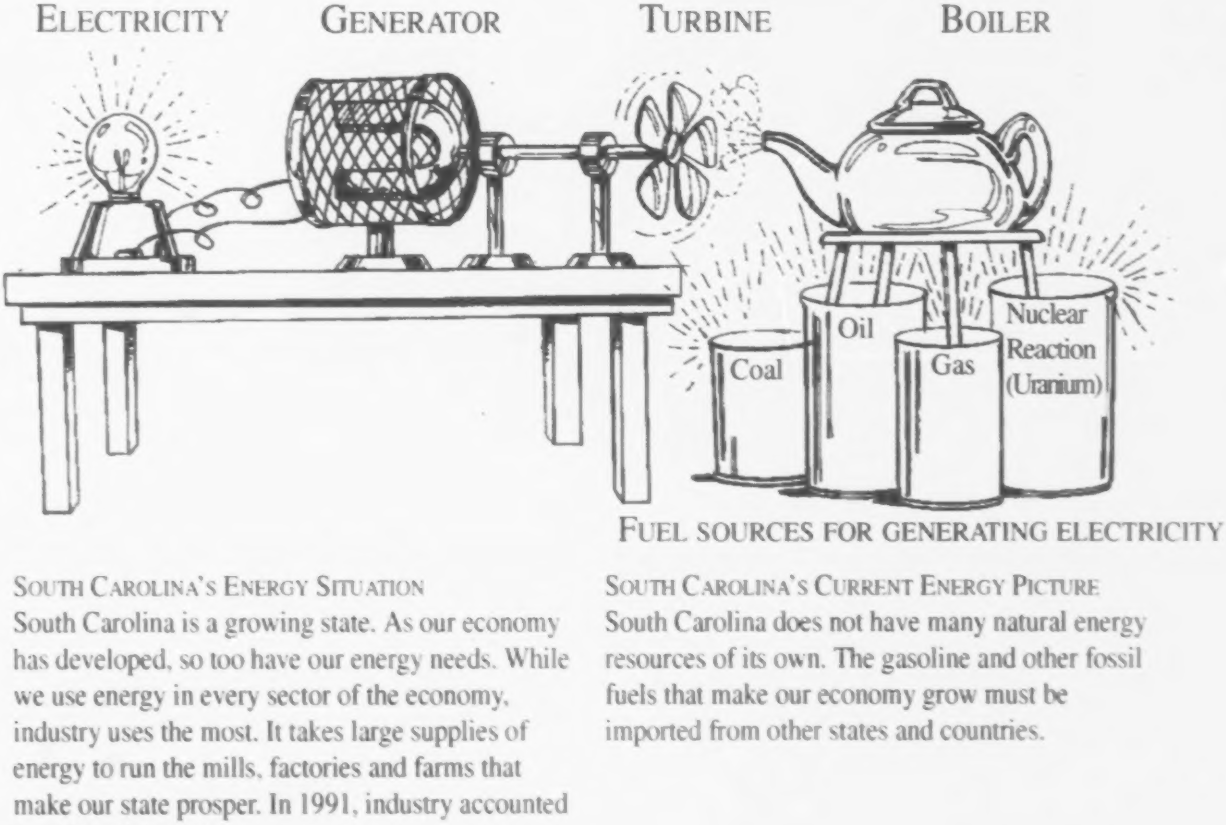
The **transportation sector** includes the cars, trucks, buses and motorcycles that run on our nation's highways. This sector also includes ships, trains, airplanes and helicopters. The energy needs for this sector are almost entirely for operating fuel.

The transportation sector is the second largest user of energy. Being primarily a rural state, this is not surprising. We are, by necessity, a state of drivers. It takes nearly two billion gallons of gasoline a year to keep South Carolinians on the move!

We use less energy in our homes. Twenty percent of the energy used in South Carolina serves to heat and cool residences and run appliances.

The commercial sector uses the least amount of energy. While this is true of most of the 50 states, in South Carolina the commercial sector uses proportionately even less. Only 13% of the state's energy is used by businesses, schools and hospitals.

Producing Electricity


ELECTRICITY
GENERATOR
TURBINE
BOILER
Oil
Nuclear Reaction (Uranium)
Coal
Gas
FUEL SOURCES FOR GENERATING ELECTRICITY

SOUTH CAROLINA'S ENERGY SITUATION
South Carolina is a growing state. As our economy has developed, so too have our energy needs. While we use energy in every sector of the economy, industry uses the most. It takes large supplies of energy to run the mills, factories and farms that make our state prosper. In 1991, industry accounted for 40% of the state's energy use.

SOUTH CAROLINA'S CURRENT ENERGY PICTURE
South Carolina does not have many natural energy resources of its own. The gasoline and other fossil fuels that make our economy grow must be imported from other states and countries.

While we can't do anything about our lack of natural resources, we can do something to make us less dependent on expensive, imported fuels. With this in mind, state officials and citizens alike are actively seeking ways to improve our energy situation.

Through science and conservation, we are now using proportionally less fossil fuels. In 1990, over one-third of the state's energy needs were met by energy resources other than fossil fuels.

GENERATING ELECTRICITY

Today, most of the electricity we use is produced by power plants. The most common method uses steam. Coal, gas, oil or nuclear fuel are used to produce heat to make steam. In South Carolina, two-thirds of the electricity generated comes from nuclear power plants. In nuclear power plants the nuclear reaction produces the heat that is used to create steam.

Steam is piped to the turbine. The turbine's shaft is connected to a huge magnet in the generator. As steam turns the turbine, the magnet spins inside a coil of wire. This spinning action creates a force which causes the electrons on the metal wires to flow. Thus electrical current is produced.

From here, the electricity flows to the power plant transformer where it is "stepped up." After leaving the power plant, the electricity flows to substations of local utility companies. Here, the voltage is "stepped down" to a usable level. Electricity then flows through transmission lines from the substations to customers in the residential, industrial, and commercial sectors.

WATER POWER

Water power can also be used to generate electricity instead of steam, moving water is used to turn the turbine. To do this, water in great force is needed. This is why water-driven plants are located near rivers or lake dams.

Hydroelectric plants have been in existence since before the turn of the century. In 1900, 57% of the electricity produced in this country came from water power. Today, hydroelectric power accounts for less than 4% of the electricity generated in South Carolina. This is mostly due to the fact lakes and rivers are currently being used to their full capacity.

HOW ELECTRICITY IS SOLD

In most cases, South Carolina's electricity is generated by power plants owned by the utilities. The utilities then sell the electricity to their customers. The electricity flows to a home or building through a distribution line and enters the facility at the meter point.

Meters measure the amount of electricity used in kilowatt-hours. One kilowatt-hour is about the amount of energy needed to run an iron for one hour.

Utilities need to anticipate consumers' demand for electricity. During hot summer days, everyone wants the air conditioner on full blast. Were the electric companies not prepared for this, there would be constant power shortages or brownouts.

Anticipating demand is important because electricity cannot be stored. To meet peak needs, utilities must generate all of the electricity they can or shift demand to off-peak times or incorporate energy saving measures. Sometimes they even have to purchase electricity from other utilities.

Glossary

aerate - To expose to the circulation of air, as in aerating a compost pile.

aerobic - Able to live and grow in the presence of free oxygen; aerobic bacterial decomposition results in the conversion of organic wastes to compost.

acid anhydrides - Oxides produced by burning nonmetals that, when combined with water, form acids. As gases, acid anhydrides may dissolve in rain to form acid rain.

acid rain - Caused by emissions from the burning of fossil fuels. When fuels such as coal, oil and natural gas are burned, many substances are emitted into the air. Sulfur dioxide and nitrogen compounds which contribute to air pollution travel through the air and react with each other in sunlight to form secondary pollutants such as sulfuric acid and nitric acid. When these acids fall to earth with rain, it is called acid rain.

airborne - Carried by or through the air.

air pollution - There are five primary air pollutants: carbon monoxide, hydrocarbons, nitrogen compounds, particulate matter, and sulfur dioxide.

anaerobic - Able to live and grow only in the absence of free oxygen; anaerobic decomposition of organic wastes by bacteria results in the production and release of methane gas.

altitude - The height of something measured in relation to a reference level, such as above the Earth's surface.

aluminum - A light, strong, silver-colored metal made mostly of bauxite ore. One of the most common materials accepted for recycling.

amber glass - A term used by the glass industry to refer to brown glass.

aquifer - An underground geologic formation in which the cracks in rock, sand, soil, or gravel are filled with water.

ash monofill - A specially constructed landfill to be used only for disposing ash from waste-to-energy plants.

atmosphere - The gaseous envelope surrounding the Earth.

baler - A machine that compacts waste materials, usually into rectangular bales. Balers often are used on newspaper, plastics and corrugated cardboard.

base cup - The high density polyethylene (HDPE) plastic base found on plastic soft drink bottles made of polyethylene terephthalate (PET).

bimetal - Made of two different metals. Examples include beverage cans steel bodies and aluminum lids.

bioaccumulation - Concentration of chemicals in the fatty tissues of living organisms, which may move up the food chain over time.

biodegradable - Capable of being broken down by microorganisms into simple, stable compounds such as carbon dioxide and water.

biodiversity - The vast diversity of plants and animals on earth.

bottle bill - A law in some states requiring deposits on beverage containers. South Carolina does not have a bottle bill.

bottom ash - The incineration process produces this ash which must be landfilled.

broadsheet - A term for 18th century newspapers.

broadside - A single sheet of music.

Btu - British Thermal Unit, or a unit of heat required to raise the temperature of one pound of water one degree Fahrenheit (For example, it takes 70 Btus to heat a cup of water from room temperature (72°F) to boiling).

Bureau of Drinking Water Protection - The component of S.C. Department of Health and Environmental Control charged with permitting and assisting public drinking water facilities, monitoring public drinking water and educating the public about safe drinking water.

buy-back center - A place to sell recyclable materials.

CERCLA - An acronym for the Comprehensive Environmental Response, Liability and Compensation Act, or Superfund.

CFCs - Chlorofluorocarbons, any of various gaseous compounds of carbon, hydrogen, chlorine, and fluorine. If CFCs and their relatives are released into the air, they rise to the stratosphere. In the stratosphere, CFCs take part in chemical reactions which result in reduction of the stratospheric ozone layer, which protects the Earth's surface from harmful effects of radiation from the sun.

carbon dioxide - A common gas, CO_2 formed by respiration, combustion, and decomposition; comprises 0.03 percent of air.

carcinogen - A substance that can cause cancer.

cardboard - A kind of paper that is thicker, heavier and more rigid than other papers. It is known as paperboard within the paper industry and includes corrugated boxes and boxboard (such as cereal boxes).

caution - In labeling household hazardous waste, caution means be careful. The product should be used with care.

cell - An area in a landfill where solid waste is disposed of each day.

Center for Waste Minimization - A service offered by the South Carolina Department of Health and Environmental Control to help industries and businesses reduce waste.

cinquain - A form of poetry with five lines.

clarity - Clearness.

Clean Air Act - Originally passed in 1963 and amended in 1970 and 1990 to give the United States Environmental Protection Agency (U.S. EPA) the responsibility of setting air quality standards for each pollutant.

cloud - A visible mass of very fine droplets of water or particles of ice in the atmosphere above the Earth's surface.

code - A system of symbols given certain meanings, such as the numbering codes given to plastic packages to indicate the material type.

combustion - Burning of waste materials, fuels, etc.

commercial waste - Waste material that originates in wholesale business establishments such as office buildings or stores.

commingled materials - A mixture of several recyclables in one container.

compost - The product resulting from the decomposition of organic materials such as yard waste. Compost can be used as a soil conditioner.

composting - The conversion of organic materials to humus by microorganisms; an effective solid waste management method for reducing the organic portion of waste, including lawn clippings, leaves, kitchen scraps, and manure.

compost pile - A place, such as an outside pit or bin, set aside for composting waste.

Comprehensive Environmental Response, Liability and Compensation Act (CERLCA) - Passed by Congress in 1980 and usually referred to as Superfund, a fund to help pay for the management and cleanup of hazardous waste sites.

concentration - In chemistry, the amount of a specified substance in a unit amount of another substance.

condensation - The process by which a substance changes from its gaseous state to its liquid state.

conservation - The planned management of natural resources to prevent loss, destruction or waste.

consumer - A person who buys goods or services.

consuming/consumption - Buying and using goods or services.

contamination - The process of making the original substance impure or unusable.

contaminants - Compounds that pollute, making the original substance impure or unusable.

corrosive - In hazardous waste labeling, corrosive means that a product may eat through other items, such as its container.

corrugated paper - Paper or cardboard manufactured in a series of wrinkles or folds or into alternating ridges and grooves.

cover material - The soil used to cover solid waste in a landfill.

cradle to grave - In solid waste management, a look at a product from raw materials through manufacturing, use, consumption, and disposal.

cullet - Clean, generally color-sorted crushed glass used to make glass products.

cumulus - A type of cloud that is fluffy and flat based.

curbside recycling program - A program where recyclable materials are collected at our homes. The materials often are left in special containers on the curbside to be picked up by a recycling truck.

cycle - A repeated event or sequence of events.

danger - In household hazardous wastes labeling, danger means that exposure or unsafe use may cause injury, illness or death.

database - A collection of data or information arranged for computer access.

decompose - To break down into component parts or basic elements; decomposition of organic waste materials by bacteria is an essential life process because it makes essential nutrients available for use by plants and animals.

degradable - Can be decomposed, or broken down, such as yard wastes in a compost pile.

demolition debris - Waste materials produced during construction or remodeling including items such as used lumber, masonry, sheetrock, shingles, insulation, etc.

deinking - A process by which most of the ink, filler and other materials are removed from waste paper before using it to manufacture new paper.

de-tinning - A process by which the thin tin coating is removed and recovered from steel cans.

dewater - To remove the water from waste.

DHEC - The S.C. Department of Health and Environmental Control. DHEC was created in 1973 when the State Board of Health and the Pollution Control Authority merged. DHEC is responsible for protecting the state's environment and the health of South Carolinians.

diamante - A form of poetry shaped in the form of a diamond.

dilute - To make thinner or weaker as by mixing or dispersing.

disinfection - The process of treating water with chemicals or other means to kill microorganisms.

distillates -The liquid condensed from vapor in distillation.

distribution system - A series of pipes that carry clean drinking water from the water treatment plant to individual homes, schools, and businesses.

diversion rate - A measure of the amount of waste being diverted from the municipal solid waste stream either through recycling or composting.

do-it-yourselfer - A term for people who choose to change their own motor oil. These people are the focus of campaigns to get people to recycle their used motor oil.

DOT - Federal Department of Transportation.

drinking water - The water resources considered available and drinkable.

drop-off center - A designated site in the community where individuals may bring recyclables.

dump - An open, unmanaged, illegal disposal site used instead of sanitary landfills.

dumpster - A large container to keep waste until it is collected by the trash hauler. Dumpsters often are used by stores, apartment buildings and restaurants.

Earth Day - Held on April 22 each year to promote awareness of environmental issues, the first Earth Day was in 1970.

ecology - The scientific study of the relations of living things to one another and to their environment.

ecosystem - A system made up of a community of living things and the physical and chemical environment in which they interact.

editorial - An article published expressing the opinions of its editors or publishers.

effluent - Solid, liquid or gas waste that can enter the environment as a by-product of a chemical or biological process.

embedded energy - The total amount of energy an item uses during its lifetime.

emission - Substances that are given off or released from other processes, such as air pollution emissions.

end users - A business or manufacturer that takes recyclable materials and converts them into new products.

energy - The ability or capacity for doing work by a body or a system. A message of the total heat in a system. Heat can be converted between a number of forms – light, motion, electricity, and warmth.

energy recovery - Recovering energy from waste. Used to describe recycling used oil into fuel that is burned to generate heat that produces electricity.

entropy - A measure of the capacity of a system to undergo spontaneous change.

environment - All the conditions, circumstances, and influences surrounding and affecting the development or existence of people or other living things.

EPA - The U.S. Environmental Protection Agency. It is the agency of the U.S. government that sets environmental protection and enforcement standards. The EPA was created in 1970 and serves the entire country through its 10 regional offices. South Carolina is in Region IV. The agency's headquarters is in Washington, D.C.

erosion - The wearing away of rock or soil by the gradual detachment of soil or rock fragments by water, wind, ice, and other mechanical and chemical forces.

estimate - to make a judgment, to evaluate.

evaporation - The process by which a substance changes from its liquid state to its gaseous state.

exponential function - In math, expressed in terms of a designated power.

Federal Trade Commission (FTC) - The federal agency that supervises and regulates business competition by investigating unfair or harmful trade practices, such as misrepresentation in advertising.

ferrous metals - Metals that are predominantly composed of iron.

fertilizer - A material such as compost or a chemical compound added to soil to increase its fertility.

filter - A porous substance through which a gas or liquid is passed in order to remove its contaminants.

finished water - Water that has been processed for drinking at a water treatment plant.

finite - Limited in number.

flammable - Capable of igniting easily and burning quickly.

floatation deinking - A process in paper recycling where the ink is floated off paper with water.

fly ash - Small particles of ash and soot which are collected by pollution control devices during the incineration of solid wastes.

fog - Water vapor that has condensed to fine droplets lying in cloud-like masses close to the ground.

food chain - A succession of organisms in a feeding chain in which food energy is transferred from one organism to another as each consumes a lower member and is, in turn, preyed upon by a higher member.

fossil fuel - A nonrenewable energy source such as coal, petroleum, and natural gas.

garbage - Another word for solid waste, particularly household waste.

gas - One of the states of matter in which a substance has no fixed form or volume and takes the shape of its container.

generation - The act or process of producing solid waste.

geology - The study of the earth.

glasphalt - A highway paving material in which recovered ground glass replaces some of the gravel in asphalt.

GOFER - **G**ive **O**il **F**or **E**nergy **R**ecovery. Santee Cooper's used oil recycling program.

greenhouse effect - A term scientist use to describe the trapping of heat on the surface of the Earth by the atmosphere, which is a normal occurrence. This effect is magnified by certain greenhouse gases in the atmosphere – carbon dioxide, methane, nitrogen oxides, and chlorofluorocarbons.

Green Seal - One of the first companies in the United States to award an environmental seal to products that meet certain environmental requirements.

Grinding of the Greens - A statewide Christmas tree recycling project. Information may be obtained from South Carolina Clean & Beautiful. (803) 734-0141.

groundwater - Water beneath the earth's surface that moves between soil particles and rock; supplies wells and springs.

groundwater flow - The slow movement of groundwater.

habitat - Place where a plant or animal normally lives; part of an ecosystem.

haiku - A form of poetry consisting of three lines of five, seven, and five syllables each.

hazardous - Dangerous.

hazardous substance - Substances such as chemicals that, if used improperly, may be dangerous to human health and/or the environment.

hazardous waste - Waste that may pose a threat to human health or the environment. The disposal, transportation and handling of hazardous waste is regulated by federal law.

HDPE - High-density polyethylene, a plastic resin commonly used to make milk jugs, detergent containers and base cups for plastic soda bottles. The standard plastic code for HDPE is 2.

heavy metals - Natural elements such as lead, mercury, cadmium and nickel.

high grade waste paper - The most valuable waste paper in the marketplace. High grade waste paper can be substituted for virgin wood pulp in making paper. Examples include letterhead stationery and computer paper.

household hazardous waste - Waste found around the home, usually in small amounts, that can harm people or the environment. Examples of household hazardous waste include paint, pesticides, cleaning supplies and batteries. Household hazardous waste is not regulated as a hazardous waste by South Carolina law, and is considered part of the municipal solid waste stream. Because of the nature of household hazardous waste, it should be stored properly and disposed of separately from solid waste.

human-made - Made by people.

humus - Organic material consisting of decayed vegetable matter that provides nutrients for plants.

hydrology - The scientific study of the distribution, circulation, or properties of the waters of the earth.

ignitable - In hazardous waste labeling, ignitable means that products may catch fire easily.

incident light wave -

impervious - Incapable of being penetrated, as by water.

incineration - The burning of waste.

incinerator - The facility in which the burning of waste takes place, incinerators are federally regulated.

industrial scrap - Waste generated during manufacturing operations.

industrial waste - Waste that results from industrial processes, such as manufacturing.

infiltration - Passing or joining gradually.

ingestion - To take food in by swallowing.

inorganic - Things not made from plant, animal, or carbon compounds; most inorganic compounds are derived from mineral resources.

insulation - A material that prevents the passage of heat, electricity, or sound.

integrated waste management - The complementary use of a variety of practices to manage municipal solid waste safely and effectively. Integrated waste management techniques include source reduction, recycling, composting, incineration and landfilling.

joule - The International System unit of energy equal to the work done when a current of 1 ampere is passed through a resistance of 1 ohm for 1 second.

kilowatthour - A common unit of electric power consumption equal to 1,000 watts acting for one hour.

LDPE - Low density polyethylene, a plastic used in shopping bags and garbage bags. The standard plastic code for LDPE is 4.

lampoon - A satirical piece found in print.

landfill - A large outdoor site for the burial of solid waste.

landfilling - The disposal of solid waste at permitted facilities in a series of compacted layers on land with daily covering of the waste with soil. Fill areas are carefully prepared to prevent risk to public health and the environment.

large quantity generator - Industries or other concerns that generate more than 1,000 kilograms of hazardous waste per month.

leachate - Rain water or other liquid that has percolated through solid waste and has extracted possibly hazardous dissolved or suspended materials from it. Leachate must be collected and treated to prevent it from contaminating ground and surface water.

lead-acid battery - Any battery that consists of lead and sulfuric acid, has a capacity of six volts or more and is used as a power source.

life cycle analysis - A process that examines a product from raw materials, manufacturing, transportation, and disposal cycles of its life.

life cycle cost - The total cost of an item using the initial cost, expected lifetime, and cost of energy used during the item's life span.

limited supply - In terms of natural resources, resources that are not available in unrestricted amounts. In many areas even renewable resources are considered to be in limited supply.

litter - Waste materials thoughtlessly discarded in an inappropriate place; littering is against the law in South Carolina.

liquid - One of the states of matter in which the substance takes the form of its container, has the ability to flow and has a fixed volume.

mandated recycling - Programs that by law require certain recycling practices or results.

manifest - A detailed shipping form required for all hazardous waste shipments.

manual separation - Sorting recyclables from other waste by hand.

marine debris - Trash or litter in the water.

materials recovery facility (MRF, pronounced murf) - A facility processing collected recyclables for end users.

matter - Anything that takes up space and can be perceived by one of the senses.

mechanical separation - A process in which recyclables are separated by various machines using, for example, magnets or air.

meter - A device used for measurement.

methane gas - A colorless, odorless, flammable and explosive gas produced by decomposing garbage and other organic materials.

microorganisms - Animals or plants of microscopic size.

mixed paper - Waste paper of various kinds and quality. Examples include stationery, notepads, manila folders and envelopes.

mixed waste - Unsorted waste from businesses or homes.

monitor - To keep watch over or supervise.

mulch - A protective layer around plants to prevent evaporation.

municipal solid waste (MSW) - The combined residential and commercial solid waste generated in an area. MSW includes paper, cans, bottles, food scraps, yard waste and other items. Industrial process waste, agricultural waste, mining waste and sewage sludge are not MSW.

municipal solid waste landfill - Any sanitary landfill, publicly or privately owned, that receives household waste. The landfill may also receive other types of solid waste, including commercial waste, non-hazardous sludge and industrial solid waste.

NIMBY - An acronym for "Not in my back yard." An expression of opposition for the siting of a waste facility near or in a community.

natural recycling - A process by which organic material decomposes in nature, such as leaves decomposing in a forest.

natural resources - Valuable, naturally-occurring items such as plants, animals, minerals, water, and air which are used by people to help make things such as energy, food, clothes, buildings, etc.

nitrogen cycle - The continuous cyclic progression of chemical reactions in which atmospheric nitrogen is compounded, dissolved in rain, deposited in the soil, assimilated and metabolized by bacteria and plants, and returned to the atmosphere following decomposition.

newsprint - An inexpensive paper made from wood pulp or recycled paper used primarily for newspapers.

nonbiodegradable - Does not degrade or break down in a compost pile.

nonferrous metals - Metals such as aluminum, copper or brass that contain no iron.

nonhazardous - Not considered dangerous.

nonpoint source pollution - Contamination, water pollution, that comes from many diffuse sources rather than a specific point such as a factory discharge pipe.

nonrecyclable - Cannot be recycled.

nonrenewable resources - Natural resources which, because of their scarcity, the length of time required to form them, or their rapid depletion, are considered finite in amount, such as petroleum, coal, natural gas, and copper.

observation - The noting and recording of facts and events.

Office of Solid Waste Reduction and Recycling - An office established by the S.C. Solid Waste Policy and Management Act of 1991. The office is part of DHEC's Division of Solid Waste Management and is non-regulatory and non-enforcement. It is responsible for public awareness and education campaigns dealing with solid waste and recycling issues, including curriculum development, landfill operator training, recycling demonstration projects and the management of several grant programs.

on-line networks - Computer-based information services that provide immediate access to data.

organic - Made from living organisms.

organic waste - Discarded living material such as yard and food waste.

ozone - A principal component of smog. Ground level ozone is harmful and causes health effects similar to asthma, and is known to harm trees and plants. However, an ozone layer that exists naturally in the stratosphere keeps out most of the dangerous ultraviolet rays from the sun that can cause skin cancer.

PET - Polyethylene terephthalate, a plastic commonly used to make soft drink bottles. The standard plastic code for PET is 1.

PP - Polypropylene plastic.

PS - Polystyrene plastic.

packaging - The wrapping, container or sealing used to protect, identify and advertise a product.

paperstock - Waste paper that has been sorted at the source into different grades.

particulate matter - Very small, separate particles, such as a particle of dust or fiber.

parts per billion - A proportion in which one unit per billion is measured.

parts per million - A proportion in which one unit per million is measured.

percolate - To pass or ooze through, as liquid percolates through a landfill.

permeable - Capable of being passed through such as soil which is permeable by water.

pervious - Open to passage, permeable.

pesticide - Any substance designed to kill living organisms, including insects (insecticides), plants (herbicides), fungi (fungicides), rats and mice (rodenticides), and bacteria (germicides).

petroleum - A natural, flammable liquid hydrocarbon mixture found principally beneath the earth's surface and processed to make gasoline, natural gas, naphtha, fuel, and lubricating oils. Also called crude oil.

pH - A numerical measure of the acidity of a substance, ranging from very low pH values such as 3 (vinegar) through neutral (7) to high values like 10 (lye).

photochemical reaction - A chemical reaction in the atmosphere that is triggered by sunlight. Pollutants often are created by photochemical reactions.

photosynthesis - Radiant energy from the sun is captured by green plants and converted into chemical energy during photosynthesis. Photosynthesis uses carbon dioxide and water and releases oxygen.

plankton - Plant and animal organisms, generally microscopic, that float and/or drift in great numbers in fresh or salt water.

planned obsolescence - Designed to be useful for a specific period of time, such as paper plates and cups which are designed to be used and throw away.

plastic - A man-made material made from hydrocarbons known for its light weight and durability.

poison - A substance that, through its chemical action, usually kills, injures or impairs a living thing.

political cartoon - Cartoon illustrations created to make a statement about politics.

pollution - Harmful substances deposited in the air, water, or on land, leading to contamination of the environment

polyethylene - A common plastic used to make plastic bags (LDPE standard plastic code 4) and milk bottles (HDPE standard plastic code 2).

polypropylene - A common plastic used to make deli tubs and straws (PP standard plastic code 5).

polystyrene - A lightweight plastic material often used in food service. Polystyrene products include trays, plates, bowls, cups and hinged containers (PS standard plastic code 6).

pore space - Tiny spaces between each grain of soil, sediment or within rock that can be filled by air or water.

post-consumer materials - Recovered materials that have been used by consumers.

precipitation - Water that falls as rain or snow.

pre-consumer materials - Recovered materials obtained from manufacturers, such as cutting scraps from printers

precycle - To reduce waste at the source by changing buying habits.

primary materials - Virgin or new materials, such as wood pulp and iron ore, used in making products.

profit margin - The margin or portion of the price paid for a product that is in excess of the company's expenses.

public service announcement - A commercial message broadcast for public good at no cost.

pulp - A soft, moist, sticky mass of fibers made up of wood, straw, etc., and used to make paper and paperboard.

pyrolysis - A chemical change caused by an increase in temperature.

RCRA - An acronym for Resource Conservation and Recovery Act.

rain - Water that condenses from atmospheric vapor and falls to earth as drops.
reactive - In hazardous waste labeling, reactive means that a product may explode.

recharge - To fill, as water seeps into the ground to fill aquifers and groundwater supplies.

recyclable - Products or materials that can be collected, separated and processed to be used as raw materials in the manufacture of new products.

recycle - To collect, separate, process and market materials so they can be used again.

recycled content - The amount of a product's weight or package's weight that is composed of materials that have been recovered from waste. Recycled content may include pre-consumer and post-consumer materials.

reduce - To lessen in amount. Reducing trash is a major solid waste management goal.

refurbish - Repair and make useful.

refuse - A general term for solid waste materials, also called garbage or trash.

renewable resource - A natural resource derived from an endless or cyclical source (e.g., sun, wind, trees, fish); with proper management and wise use, replacement of these resources by natural or human-assisted systems can be approximately equal to their consumption.

reprocessing - To process again. Re-refining used oil into new oil is a form of reprocessing.

re-refining - To refine again. Used oil that is reprocessed into new oil products is considered re-refined.

reservoir - A body of water stored for future use.

residue - The remainder of something after the removal of part.

resin - In plastics manufacturing, the different compounds used to create the different forms of plastic.

resource - A supply of something that can be used or drawn upon; something that can be used to make something else-wood into paper, bauxite ore into aluminum, old bottles into new ones, sand into glass, etc.

Resource Conservation and Recovery Act (RCRA) - Passed in 1976 to direct the Environmental Protection Agency to get involved in preventing industrial hazardous waste problems.

resource recovery - Use of high technology to burn mixed solid waste and produce energy; may involve mechanical separation of recyclables.

reuse - The use of a product more than once for any purpose.

runoff - Precipitation that hits the ground and runs down streets or over land

Safe Drinking Water Act - A rule originally passed by Congress in 1974. Its purpose is to make sure that drinking water supplied to the public is clean and safe. The Environmental Protection Agency sets the national drinking water standards and grant those states that meet certain criteria the task of managing their own public drinking water.

salt water intrusion - A process whereby salt water enters an area that once contained only groundwater.

SARA Title III - An acronym for Superfund Amendments and Reauthorization Act, which requires the release of information regarding toxic chemicals.

sanitary landfill - See municipal solid waste landfill.

scrap - Waste with some value, particularly material left over from construction or manufacturing suitable for reprocessing.

secchi disk - A device used to test the clarity of water.

secondary materials - Used materials, such as waste paper or scrap metal, handled by dealers and brokers.

sediments - Soil particles carried into water bodies.

septic tank - A tank .into which sewage is discharged and decomposed by bacteria.

sewage - Mostly liquid waste, including human waste, which is transported away by sewers and purified in a sewage treatment plant.

sewage sludge - The muddy sediment left after sewage has been processed.

sewer system - Pipes that carry sewage away from homes to sewage treatment plants.

short-term impact - Immediate circumstances.

sinkhole - A natural depression of land formed by collapse of an underlying cavern roof.

small quantity generator - A small business, school, hospital or other concern that generates less than 1,000 kilograms of hazardous waste per month.

smog - A mixture of pollutants, principally ground-level ozone, produced by chemical reactions in the air of smog-forming chemicals. Smog can harm health, damage the environment, and cause poor visibility.

soil - The top layer of the earth's surface.

solid - Any substance that cannot flow, takes up space and has a definite shape and volume.

solid waste - Trash and garbage. In the S.C. Solid Waste Policy and Management Act of 1991, solid waste is defined as any garbage, refuse, or sludge from a waste treatment facility, water supply plant, or air pollution control facility; and other discarded material. It also includes solid, liquid, semi-solid, or contained gaseous material resulting from industrial, commercial, mining and agricultural operations and community activities.

Solid Waste Disposal Act - A federal law passed in 1965 and amended in1970 that addressed waste disposal methods, waste management, and resource recovery.

solid waste management - The handling, processing and disposal of all solid waste.

solid waste stream - What we throw away.

soot - A fine, black powder formed by combustion or separated from fuel during combustion.

source reduction - Behavior to deliberately reduce waste through educated consumer choices and disposal.

source separation - Separating recyclable materials at the source, such as at home or office.

source water -Untreated water from a river, stream, lake or groundwater that is used to produce clean drinking water.

South Carolina Clean & Beautiful - A statewide educational program with local Keep America Beautiful affiliates conducting a variety of projects including the Adopt A Highway Program, Carolina Spring Clean, Take Pride in Public Lands, and Grinding of the Greens.

South Carolina Recycling Association - A non-profit organization established to promote recycling through education. The SCRA, based in Columbia, S.C., publishes a newsletter, has a resource library and sponsors workshops, conferences and seminars throughout the year across the state.

South Carolina Solid Waste Policy and Management Act of 1991 - The first comprehensive law dealing with solid waste management in South Carolina. The law establishes a policy of promoting solid waste reduction, recycling and reuse of materials before landfilling or incineration. It sets a goal of reducing the amount of solid waste being received at municipal solid waste landfills and incinerators by 30 percent, calculated by weight, by May 1997. It also sets a goal of recycling 25 percent, calculated by weight, of the total waste stream by May 1997. The bill was signed into law by Governor Carroll A. Campbell on May 27, 1991.

South Carolina Used Oil Partnership - A public-private partnership formed in May 1992 to increase public awareness about the importance of proper disposal of used oil. The partnership consists of DHEC's Office of Solid Waste Reduction and Recycling, Santee Cooper, the S.C. Department of Transportation and the S.C. Petroleum Council.

stagnant - Not moving or flowing, motionless.

states of mater - Three different forms (solid, liquid, and gas) in which one substance can occur dependent upon temperature.

static - In the term static use, use that stays at the same level and does not increase.

storm drains - Gutters and underground pipes that carry storm and runoff water away from streets.

Subtitle D - The solid, nonhazardous waste section of the Resource Conservation and Recovery Act (RCRA). Subtitle D provides specific information about landfill design, operation and closure.

Superfund - A large federal trust fund for cleaning up hazardous waste sites considered dangerous. Part of CERCLA.

surface area - A measurement of a rectangle or square that equals the length multiplied by the width.

surface water - Surface waters include streams, rivers, ponds, lakes, and manmade reservoirs. All fresh water that is not absorbed into the earth (becoming groundwater) or returned to the atmosphere as part of the water cycle is considered surface water. Only about .02 percent of all water on Earth is surface (fresh) water.

sustainable development - An environmental protection strategy designed to protect the earth's resources.

temperature - The degree of hotness or coldness of an object (a measure of energy).

TSDs - An acronym for treatment, storage and disposal facilities. These are facilities that are permitted to handle hazardous wastes.

thermodynamics - The physics of the relationships (dynamics) between heat (thermo) and other forms of energy.

throwaway life style - A phrase describing modern life with many disposable products and short-lived goods.

tipping fee - The price individuals, communities and trash haulers pay to dispose of their waste at a landfill.

topographic maps - Maps that show the physical features of a region.

topography - Detailed description or representation of the physical features of the region.

toxic - Poisonous.

toxicity - The degree of danger posed by a toxic or poisonous substance to animal or plant life.

trash - Material considered worthless, unnecessary, or offensive that is usually thrown away.

transfer station - A facility where waste is removed from small collection vehicles and loaded onto larger transport vehicles.

transpiration - To give off water vapor containing waste products.

turbidity - A measure of the amount of material suspended in water.

UBC - An acronym for Used Beverage Container, usually plastic soda bottles and aluminum cans.

used motor oil - Motor oil that has been used in an engine and is considered to be waste. Today this oil can be recycled.

vapor - A substance in the gaseous state that is ordinarily a liquid or solid.

V - Vinyl plastic.

Vinyl plastic - A common type of plastic used to make shampoo bottles and other containers (V standard plastic code 3).

virgin materials - Any basic material for industrial processes that has not previously been used. Examples include timber or metal ore.

volume - The amount of space an object can occupy. Solid waste may be measured by weight or volume.

warning - In household hazardous products labeling, warning means a stronger risk than caution, use with added care.

waste - Anything which is discarded or not considered useful.

waste audit - An inventory of the amount and type of solid waste that is produced at a specific location.

waste exchange - A program that helps companies offer some of their hazardous waste byproducts to other companies that may be able to use these wastes in their business.

waste reduction - An important waste management strategy that encourages people to generate less trash by watching what they buy.

waste stream - All the waste generated in an area or a facility.

waste-to-energy plants - Facilities that burn solid waste to produce energy.

wastewater - Water that has been used, either to manufacture a product or in the home, and which requires treatment and purification before it can be used again.

water - A molecule containing one oxygen and two hydrogen atoms.

water cycle - A series of naturally occurring events in which water is changed from a liquid to a gas (evaporation), rises into the atmosphere above Earth, is condensed into a form of precipitation and falls back to Earth some of which soaks down below the Earth's surface into the groundwater. The water cycle also includes transpiration of water by plant life.

water meter - A device which measures the amount of water flow.

Water Pollution Control Act - Passed in 1972 to allow the Environmental Protection Agency to set water quality standards and regulate water pollution.

watershed - The geographic region within which water drains into a particular body of water.

water table - The depth or level below which the ground is saturated with water.

water treatment plant - A facility where source water is cleaned and disinfected to meet Federal Safe Drinking Water standards.

water vapor - Water in its gaseous state.

waterways - Navigatable bodies of water, as a river.

well - A deep hole dug down in the ground to obtain water or other substances.

white goods - Appliances such as refrigerators, stoves, water heaters, washing machines, dryers and air conditioners.

yard waste - Grass clippings, shrub prunings, leaves, tree branches and other discarded material from yards and gardens.

BOOKS, VIDEOS, AND OTHER INFORMATION

The South Carolina Department of Health and Environmental Control's Office of Solid Waste Reduction and Recycling has a Resource Center in Columbia. This center has videos, books, and current information on many environmental topics.

The Resource Center is staffed by a librarian who can assist you and your students with research on a variety of topics related to solid waste and environmental conservation. Students are welcome to conduct their research in-person or may request that the research be conducted for them. Materials will be mailed as available.

To reserve materials for use in your classroom, please call, 1-800-768-7348, or write to the Department of Health and Environmental Control, Resource Center of the Office of Solid Waste Reduction and Recycling, 2600 Bull Street, Columbia, South Carolina 29201. We're here to help.

Some of the resources that may be accessed include:

Directories
- The American Recycling Markets Guide
- The Recycled Products Guide
- South Carolina Recycles: a directory of recycling programs and markets
- Index of Waste Minimization Resources for South Carolina Industries
- South Carolina Industrial Directory
- Access EPA: a directory of U.S. EPA and other public sector environmental resources

Topical Files

These files include information collected from a variety of sources, filed alphabetically by topic, including fact sheets, case studies, journal articles, promotional materials, reports and vendor information. Topics include batteries, composting, landfills, paper, recycling markets, plastics, metals, glass, recycling programs, incineration, tires, and white goods (appliances).

Journal Index

This is an electronic index of solid waste and recycling journals. The index is searched by toic and provides a citation including the title of the article, the name of the journal, and whe it appeared. The journals themselves are housed in the Resource Center in Columbia. Journals indexed include:

- *American City and County*
- *Biocycle*
- *Bottle/Can Update*
- *Environmental Headline News*
- *MSW Management*
- *Pollution Prevention News*
- *Recycling Times*
- *Recycling Today*
- *Resource Recycling*
- *Reusable News*
- *Solid Waste Technologies*
- *Solid Waste Digest*
- *Solid Waste Report*
- *Steel Can Recycling Newsletter*
- *Waste Age*
- *World Wastes*

Books
These resources may be checked out upon request. Available are a variety of titles including elementary fiction, environmental reference, and activity books. Please call for information, as new titles are being added all the time.

Videos
Videos may be checked out as needed. Topics include recycling, used oil, over population, and air quality.

In-House Publications
The Resource makes available in quanities brochures and fact sheets published by the Office of Solid Waste Reduction and Recycling. These are generally South Carolina specific. Topics include recycling, composting, used oil recycling, scrap tire recycling, buying recycled, and fun recycling facts.

U.S. EPA Publications
Many U.S. EPA documents related to recycling, solid waste, and environmental protection are available in the Resource Center.

On-Line Resources
A variety of on-line services may be searched in the Resource Center. These include Solid Waste Information Clearinghouse, Eco-Net, Recycleline, the Pollution Prevention Information Clearinghouse, and Environet.

Regulatory Documents
Copies of South Carolina Environmental Regulations are available from the Resource Center.

In addition to the Resource Center of the Office of Solid Waste Reduction and Recycling, other Department of Health and Environmental Control Bureau's can provide educational support.

For additional information on air quality, please contact Susan Provence, Bureau of Air Quality, SC DHEC, 2600 Bull Street, Columbia, SC 29201. (803) 734-2862.

For additional information on water pollution, please contact Beth Miller, Bureau of Water Pollution Control, SC DHEC, 2600 Bull Street, Columbia, SC 29201. (803) 734-0866.

For additional information on drinking water, please contact Janet Clarke, Bureau of Drinking Water Protection, SC DHEC, 2600 Bull Street, Columbia, SC 29201. (803) 734-6097.

Read More About It ...

Several of these books are available in the Resource Center. Other titles may be available in your local library or book store.

The 1993 Information Please Environmental Almanac, World Resources Institute, Houghton Mifflin.

The 1994 Information Please Environmental Almanac, World Resources Institute, Houghton Mifflin.

Environmental Literacy: The A to Z Guide, Steven Dashefsky, Random House.

1993 Earth Journal, editors of *Buzzworm* magazine, Buzzworm Books.

Earth in the Balance: Ecology and the Human Spirit, Vice President Al Gore, Houghton Mifflin.

The Rolling Stone Environmental Reader, the editors of Rolling Stone magazine, Island Press.

State of the World 1992, Lester Brown, W.W. Norton, New York. (Annual Worldwatch Institute report)

Rubbish!: The Archaeology of Garbage, William Rathje and Cullen Murphy, HarperCollins, New York.

The Garbage Primer A Handbook for Citizens, The League of Women Voters, Lyons & Burford, New York.

The Directory of National Environmental Organizations, John C. Brainard and Roger N. McGrath, St. Paul.

The Encyclopedia of Environmental Studies, William Ashworth, Facts On File, New York.

EcoLinking – Everyone's Guide to Online Environmental Information, Don Ritter, Peachpit Press, Berkeley.

Environmental Success Index 1992, Renew America, Washington, DC.

The Green Encyclopedia, Irene Franck and David Brownstone, Prentice Hall General Reference, New York.

World Resources 1992 -1993, The World Resources Institute, The United Nations Environment Programme and the United Nations Development Programme, Oxford University Press, New York.

Recycle!: A Handbook for Kids, Gail Gibson, Little, Brown and Co.

A River Ran Wild, Lynne Cherry, Harcourt Brace Jovanovich, New York.

Just A Dream, Chris Van Allsburg, Houghton Mifflin Books, Boston.

Taking Out The Trash, Island Press.

Save The Earth: Big Book of Questions and Answers, Linda Schwartz, Publications International.

Earth Child, Carol Haralson, Council Oak Books, Tulsa.

The Great Kapok Tree: A Tale of the Amazon Rain Forest, Lynne Cherry, Harcourt Brace Jovanovich, New York.

The Mountain, Peter Parnall, Doubleday and Co., New York.

The Lost Lake, Allen Say, Houghton Mifflin, Boston.

Bangalee, Stephen Cosgrove.

Where Does the Garbage Go?, Paul Showers, Crowell.

Dear Garbage Man, Gene Zion, Harper & Row.

Heloise: Tips for a Healthy Planet.

Our Dirty Land, Sarah Elliott, Messner.

Recycling: Reusing Our World's Solid Waste, James Hahn.

Energy: The New Look, Margaret O. Hyde, McGraw-Hill.

Waste Technology, Ann Zane Shanks, Viking.

Going Green, John Elkington, Julia Hailes, Douglas Hill, and Joel Makower, Puffin Books.

The Kids Nature Book: 365 Indoor/Outdoor Activities, Susan Milord, Williamson Publishing.

50 Simple Things Kids Can Do to Save the Earth, The Earth Works Group, Earthworks Press.

The Next Step:50 More Things Kids Can Do to Save the Earth, The Earth Works Group, Earthworks Press.

The Student Environmental Action Guide, The Earth Works Group, Earthworks Press.

The Lorax, Dr. Seus, Random House.

The Planet of Trash: An Environmental Fable, George Poppel, National Press.

The Wump World, Bill Peet, Houghton Mifflin.

The Green Consumer, Joel Makower, Penguin Books.

Backyard Composting, Harmonious Technologies, Harmonious Press.

Worms Eat My Garbage, Mary Appelhof, Flower Press.

Antarctica, The Last Unspoiled Continent, Laurence Pringle, Simon and Shuster, New York.

Likeable Recyclables, Creative Ideas for Reusing Bags, Boxes, Cans, and Cartons, Linda Schwartz, Learning Works, Santa Barbara.

Energy Projects for Young Scientists, National Energy Foundation, Robert Gardner, Franklin Watts.

Energy for Tomorrow's World, World Energy Council, St. Martin's Press.

Atoms To Electricity, U.S. Department of Energy, Assistant Secretary for Nuclear Energy, Office of Support Programs. DOE/NE-0085 November 1987.

Conservation II - Science Activities in Energy, with teachers guide,Prepared by Oak Ridge Associated Laboratories, Oak Ridge, TN. Prepared for the U.S. Department of Energy, Office of Energy Research, Washington, D.C. 20585.

Solar Energy - Science Activities in Energy, Prepared by Oak Ridge Associated Laboratories, Oak Ridge, TN. Prepared for the U.S. Department of Energy, Office of Energy Research, Washington, D.C. 20585.

Solar Energy II- Science Activities in Energy, Prepared by Oak Ridge Associated Laboratories, Oak Ridge, TN. Prepared for the U.S. Department of Energy, Office of Energy Research, Washington, D.C. 20585.

Solar Science Projects - Southface Energy Institute, Atlanta, GA.

Science Projects in Renewable Energy and Energy Efficiency, A Guide for Elementary and Secondary School Teachers, National Renewable Energy Laboratory, Golden, CO.

Teach With Energy, Fundamental Energy, Electricity and Science Lessons for Grades 4 - 6, The National Energy Foundation, Salt Lake, UT.

Teach With Energy, Fundamental Energy, Electricity and Science Lessons for Grades K-3, The National Energy Foundation, Salt Lake, UT.

Energy Glossary, The National Energy Foundation, Salt Lake, UT.

The Energy Book, The South Carolina Department of Education.

Quick Energy For Elementary Teachers, The National Energy Foundation, Salt Lake, UT.

Energy and Economics, The National Energy Foundation, Salt Lake, UT.

The Energy Factbook, A Resource for South Carolina, The South Carolina Energy Office, Columbia, SC, 1995.

Periodicals/Magazines

American Forests, published bimonthly by American Forests, P.O. Box 2000, Washington, D.C. 20013.

*The Amicus Journal, T*he American Horticultural Society, 7931 E. Boulevard Dr. Alexandria, VA 22308.

*Audubon, t*he National Audubon Society, 700 Broadway, New York, NY 10003.

Biocycle: Journal of Waste Recycling, J.G. Press, Inc., (215) 967-4135. $55/year, 12 issues. A monthly journal specializing in organic composting, recycling, and reuse.

Buzzworm, Buzzworm, Inc., 2305 Canyon Blvd. Ste. 206, Boulder, CO 80302.

E: The Environmental Magazine, Earth Action Network, Inc., 28 Knight Street, Norwalk, CT 06851, (203) 854-5559. $20/year, 6 issues. A bimonthly magazine covering a wide range of environmental issues with regular articles on solid waste management.

EPA Reusable News, Environmental Protection Agency, Office of Solid Waste and Emergency Response, 401 M Street, SW, Washington, DC 20460. A quarterly newsletter on U.S. EPA's efforts and others regarding municipal solid waste management.

EPA Used Oil Recycling, Environmental Protection Agency, Office of Solid Waste and Emergency Response, OS-323, 401 M Street SW, Washington, DC 20460. A quarterly newsletter covering local, state, and national news and developments regarding used oil recycling.

Garbage: The Practical Journal for the Environment, Old House Journal Corp., 435 9th Street, Brooklyn, NY 11215, (718) 788-1700. An environmental magazine covering topical recycling and waste management issues.

*The Green Consumer Letter/The Green Business Letter, Tilden Press, 1*526 Connecticut Ave., NW, Washington, DC 20036. Written by Joel Makower.

Household Hazardous Waste Management News, Waste Watch Center, 16 Haverhill Street, Andover, MA 01810, (508) 470-3044. Published quarterly; subscriptions are free. A newsletter focusing on regional, national, and international household hazardous waste management efforts.

Recycling Times, Waste Age's Recycling Times, 5615 W. Cermak Road, Cierco, IL 60650. $95/year, 26 issues. A biweekly newspaper on recycling markets published by the National Solid Waste Management Association.

Recycling World, Environmental Defense Fund, 257 Park Avenue South, New York, NY 10010. Published irregularly; single copy free with stamped, self-addressed envelope. A newsletter promoting practical action for the environment.

Sierra, Sierra Club, 730 Polk Street, San Francisco, CA 94109.

Solid Waste & Power: The Magazine of Waste Management Solutions, (816) 931-1311. $49/year, 7 issues. A bimonthly magazine aimed at waste-to-energy systems and recycling.

Waste Age, 1730 Rhode Island Avenue, Suite 1000, NW, Washington, DC 20036, (202) 861-0708. $45/year, 12 issues. A monthly magazine focusing on the industry and technology of waste systems.

WorldWatch, WorldWatch Institute, 1776 Massachusetts Ave., NW, Washington, DC 20036.

Resources on Video, Slides and Tape...

To reserve videos for use in your classroom, please call, 1 800 768 7348. We're here to help.

THE ROTTEN TRUTH

30 Minutes
All ages

Produced by Children's Television Network. Looks at the amount of garbage we produce, and how it is landfilled, combusted, or recycled. This video is designed for middle school students, but is entertaining enough for anyone from older elementary students to adults.

HERE TODAY, HERE TOMORROW

15 Minutes
Grades 1 to 4

Set in the future, this video looks at the amount of garbage produced, and how we are running out of landfill space. Produced by the Aid Association for Lutherans.

WORKING TOGETHER FOR A HEALTHIER PLANET

15 Minutes
Middle School to Adults

Produced by The Society of the Plastics Industry. Looks at the composition of the waste stream. Addresses some concerns about plastics disposal and recycling.

RECYCLE THIS! ROCK 'N ROLL AND RECYCLING

40 Minutes
Middle School

Entertainment style, song and dance. This lively video looks at landfill problems and what can be recycled.

A POPULAR LITTLE PLANET

30 Minutes

Produced by 3-2-1 Contact. See the effect of population growth on our environment.

GET BUSY: HOW KIDS CAN SAVE THE PLANET

30 Minutes

Produced by 3-2-1 Contact. Explore the positive and negative effects of modern technology and see kids who are making important efforts.

YOUR TOXIC TRASH

30 Minutes
Middle and High School

Produced by KERA-TV in Dallas/Ft. Worth. Ed Begley, Jr. looks at household hazardous material in your home.

BOTTOM OF THE BARREL

30 Minutes
Elementary and Middle School
Produced by the Children's Television Network and available through 3-2-1 Contact. This video looks at the many uses of oil in our society and the environmental concerns.

Videos from other Sources

YAKETY YAK – TAKE IT BACK

45 Minutes
Elementary and Middle School
Promotes the 3R's message through short skits using animation and celebrities.

DOWN THE DRAIN

30 Minutes
Elementary and Middle School
Produced by the Children's Television Network and available through 3-2-1 Contact. This video explores drinking water and how the water you drink today is the same water dinosaurs drank. Explores the water cycle and water conservation and preservation.

YOU CAN'T GROW HOME AGAIN

60 Minutes
Elementary and Middle School
Produced by the Children's Television Network and available through Contact. This video looks at what's being done to save rainforests and their inhabitants.

TOMORROW'S ENERGY TODAY & TOMORROW'S ENERGY TODAY: THE ENERGY EFFICIENT OPTION

23 Minutes and 26 Minutes
Middle School and High School
Produced by the Children's Television Network and available through Contact. This video looks at what's being done to save rainforests and their inhabitants.

The following videos are available through South Carolina Clean & Beautiful

For more information on resources available from the organization, write or call 1205 Pendleton Street, Suite 517, Columbia, South Carolina 29201, 803 734-0141.

CLEAN GETAWAY

20 Minutes
An original musical comedy featuring a cast of five characters: Detective Curbside, his sidekick Sam, Coffee Man, Convenience Lady, and the Chip Kid. The audience gets to act as jury in deciding the trios innocence or guilt. Offers recycling, waste reduction, and reuse options.

GONE WITH THE WASTE

16:32 Minutes

From the U.S. Environmental Protection Agency. Emphasizes the importance of the South's natural resources and the threat of the growing amount of trash. Explains the EPA's solution to the solid waste problem through source reduction, combustion, recycling, and landfilling.

HOW DID THIS GET HERE?

9:22 Minutes

From Keep America Beautiful, Inc. and RJR Nabisco. Gives brief overview of solid waste and litter problems and then examines where litter originates. Also examines the role of Keep America Beautiful in stopping the litter problem.

KEEP IT CLEAN

18:17 Minutes

From the Garden Club of Georgia. Sonny Shroyer takes his young friends on a nature club field trip during which they discover Woodsy the Owl making a video of trash located in the woods. Emphasis is placed on the need to care for our natural resources. Sonny and his friends continue their walk and discover Smokey the Bear who presents the fact that misplaced waste is dangerous and can cause fires. After their visit with Smokey, they meet a magician who turns trash into cash. Recycling of aluminum, glass, paper, and magazines is discussed. Advantages of recycling and guidelines for recycling are also discussed. Note: "Trash into Cash" is not always an option for individuals or communities.

OVERVIEW: SOLID WASTE DISPOSAL ALTERNATIVES

25 Minutes

From Keep America Beautiful, Inc. Explores the solid waste problem and its alternatives, by discussing land filling, waste-to-energy, composting, source reduction, recycling, and composting.

RUDY MANCKE - ETV NATURE SCENE: 11 Spots SC Governor's Task Force on Litter: 2 PSA's

41:45 Minutes

From SC Educational TV, Governor's Task Force on Litter for SC Clean & Beautiful. Naturalist Rudy Mancke visits locations dealing with the environment, litter enforcement, recycling, and natural resources. These spots include: visiting a landfill, man and nature as one (using a landfill), boating on lakes and the importance of not littering in the water, the mountains of SC and the importance of water resources, responsibility of controlling litter, natural areas and problems with litter. Also, protection of natural areas and the responsibility of citizens, the beaches of SC, the world of nature and its diversity, heritage of South Carolinians, and the world of nature and recycling. The ETV spots are followed by two Governor's Task Force on Litter PSA's that include: Nothing Could be Finer than a Cleaner Carolina public service announcement that shows wildlife in the woods, and a PSA that shows littering.

TAKE PRIDE IN AMERICA Release Tape

11:08 Minutes

Lois Gossett, Jr. explains the importance of being a "Good Guy" and preserving the earth's natural resources by taking responsibility and treating the land as if it truly belongs to us.

THIS WAS YOUR PLANET

7 Minutes

From Quality Forward, Keep America Beautiful System. A teenager dreams he is a contestant on a game show set in the future. Shows how the planet will be if he and his friends don't take steps to stop litter now.

MR. ROGERS - THE ENVIRONMENT AND RECYCLING

30 Minutes

From the Public Broadcasting System and Keep America Beautiful. Mr. Rogers visits a recycling center.

A USER'S GUIDE TO PLANET EARTH

30 Minutes

In this network television special, the viewer is challenged to answer 20 environmental questions, then scored on his answers. Tom Selleck hosts, and questions are answered and explained by television and movie personalities such as Bette Midler, Candice Bergen, and Kermit and Miss Piggy.

GLASS: ALL NATURAL, ALL RECYCLABLE

9:26 Minutes

From Carolinas Glass Recycling Program. This tape describes how glass is made, its recyclability, the advantages of glass recycling, and attitudes toward glass containers. It states that the results of a survey indicate that glass recycling reduces litter, saves landfill space, conserves natural resources, conserves energy, and generates income.

HOW PAPER RECYCLING WORKS

12:45 Minutes

From the American Paper Institute. A step-by-step guide to the various types of paper recycling. Examines the collection methods, transportation and market possibilities of recycled paper.

THE LANDFILL STORY

17:24 Minutes

From Browning-Ferris Industries. Follow two reporters as they tour a local landfill and interview the landfill manager. The processes of selecting a landfill site, preparing it, and closing it are described in detail. Information on sanitary landfills is included.

LEARN AND EARN

5 Minutes

From Phoenix Recycling. Overview of Phoenix Recycling Inc.'s plastic bag recycling program available for schools.

ONE STOP SHOPPING, ONE STOP RECYCLING

6 Minutes

From the Glass Containers Industry. The advantages of one-stop curbside collection recycling programs are compared to the disadvantages of force deposit laws. One-stop collection, just like one-stop grocery store shopping, is seen as the solution of choice, simple and convenient.

PLASTICS RECYCLING TODAY: A GROWING RESOURCE

11:38 Minutes

From The Council for Solid Waste Solutions. Examines the plastics recycling industry by explaining what types can be recycled, how it is recycled, and how it is used.

RECYCLING: IT'S NATURE'S WAY

6:40 Minutes

From Alcoa Aluminum Recycling. Aluminum recycling from can to metal and back to can is discussed. The impact of recycling is shown by discussing the savings of energy and raw materials, the effect on the economy and the environment, the ability to make money through recycling, and the savings of natural resources. Reference is made to the Aluminum Cans for Burned Children Program.

THE RESOURCE REVOLUTION

12 Minutes

Grades 7-12

From The Council for Solid Waste Solutions. This film shows the gains in plastics recycling and the role recycling plays in dealing with our nation's garbage crisis. Includes teacher's guide that will help inspire students to get involved in recycling.

STEEL: AMERICA'S MOST RECYCLED MATERIAL

8 Minutes

From the Steel Can Recycling Institute. Discusses the heightened awareness of both government and public towards steel can recycling. Discusses the steel industries history of recycling and encourages an increase in recycling efforts. Also discusses the efforts of the Steel Can Recycling Institute to promote steel recycling in businesses and communities.

The following are available through Clemson University

For information on the many resources available from Clemson University, contact your local extension office.

AN R-DAY FOR YOUR COMMUNITY

10 minutes

How to develop and conduct an R-Day (recycling day). Advice from the Governor's Task Force on Litter and Keep America Beautiful.

604

DRINKING WATER: QUALITY ON TAP

27 minutes

General introduction to the issue of water quality and protection. 1992.

ENVIROSHOPPING

20 minutes (80 slides with script and tape)

Highlights concepts of reduce, reuse, recycle, reject, and respond as they relate to solid waste and targets decision making in the marketplace. 1992.

4-H WATER QUALITY

Four video tapes 10 minutes each

Topics are: ground water, saving water, surface water, and waste water treatment.

RECYCLE YARD WASTES BY COMPOSTING

64 color slides with script

Explains the composting process. 1991.

SOLID WASTE LEGISLATION FOR SOUTH CAROLINA

90 minutes

Examines the South Carolina Solid Waste Policy and Management Act. 1991.

Other Sources of Information

For more information about solid waste, recycling, or the environment, there are a number of places teachers can contact for help.

Air and Waste Management Association, P.O. Box 2861, Pittsburg, PA 15230. (412) 232-3444.

Aluminum Association, 900-19th St. N.W., Washington, D.C. 20006. (202) 862-5100.

Aluminum Recycling Association, 1000 16th St. N.W., Suite 603, Washington, D.C. 20036. (202) 785-0951.

American Forest and Paper Institute, 260 Madison Ave., New York, N.Y. 10016. (212) 340-0654.

American Iron and Steel Institute, 11-1 - 17th St. N.W., Ste. 1300, Washington, D.C. 20005. (202) 452-7100.

American Petroleum Institute, 1220 "L" St. N.W., Washington, D.C. 20005. (202) 682-8230.

American Plastics Council, 1275 "K" St. N.W., Ste. 400, Washington, D.C. 20005. (202) 371-5319, (800) 2-HELP90.

American Retreaders Association, P.O. Box 37203, Louisville, KY 40233-7203. (502) 968-8900.

America's Clean Water Foundation, 444 North Capitol Street, NW, Suite 330, Washington, D.C. 20001. (202) 624-7833.

Composting Council, 114 S. Pitt St., Alexandria, VA 22314. (703) 739-2401.

Council for Solid Waste Solutions, 1275 K St. N.W., Washington, D.C. 20005. (202) 371-5319. Affiliate of The Society of the Plastics Industry, same address. (202) 371-5200.

Council on Packaging in the Environment, 1001 Connecticut Ave. N.W. Ste. 401, Washington, D.C. 20036-5504. (202) 331-0099.

Cousteau Society, 930 W. 21st Street, Norfolk, Virginia 23517. (804) 627-1144.

Energy Efficiency and Renewable Energy Clearinghouse, P.O. Box 3048, Merrifield, Va. 22116. (800) 363-3732.

Environmental Defense Fund, 257 Park Ave. South, New York, New York 10010. (212) 505-2100.

Environmental Protection Agency, 401 M. St., N.W., Washington, D.C. 20460. (202) 382-2080. To order U.S. EPA publications call the RCRA Hotline, (800) 424-9346.

Glass Packaging Institute, 1627 "K" St., Ste. 800, Washington, D.C. 20006. (202) 887-4850.

Hazardous Waste Management Association, 4301 Connecticut Ave. NW, Washington, D.C. 20008. (202) 244-4700.

INFORM, Inc. 381 Park Avenue South, New York, NY 10016, (212) 689-4040.

Institute of Scrap Recycling Industries, 1627 K St. N.W., Washington, D.C. 20006. (202) 466-4050.

Keep America Beautiful, 9 W. Broad Street, Stamford, CT 06902. (203) 323-8987.

Municipal Waste Management Association, 1620 "I" St. N.W., Washington, D.C. 20006. (202) 293-7330.

National Association for Plastic Container Recovery, P.O. Box 7784, Charlotte, N.C. 28241. (704) 358-8882.

National Association of Chemcial Recyclers, 12 "G" St. N.W., Ste. 800, Washington, D.C. 20005. (202) 434-8740.

National Audubon Society, 950 Third Avenue, New York, New York, 10022. (212) 832-3200.

National Geographic Society, 17th and M Streets, NW, Washington, D.C. 20240.

National Oil Recyclers Association, c/o Thelen, Martin, Johnson & Bridges, 805 15th St. N.W. Suite 900, Washington, D.C. 2005. (202) 962-3000. Also, 12429 Cedar Rd. Ste. 26, Cleveland, OH 44106. (216) 791-7316.

National Recycling Coalition, 1101 30th St. N.W. Suite 305, Washington, D.C. 20007. (202) 625-6406.

National Soft Drink Association, Solid Waste Management Dept., 1103 16th St. N.W., Washington, D.C. 20036. (202) 463-6700.

National Solid Waste Institute, 10928 North 56th St., Tampa, Fla. 33617. (813) 985-3208.

National Solid Wastes Management Association, 1730 Rhode Island Ave. N.W. Suite 1000, Washington, D.C. 20036. (202) 659-4613.

National Tire Dealers and Retreaders Association, 1250 1 St. N.W., Suite 400, Washington, D.C. 20005. (202) 789-2300, (800) 87-NTDRA.

Plastics Institute of America, 227 Fairfield Rd., Ste. 307, Fairfield, NJ 07004-1932. (201) 808-5950.

Recycled Products Information Clearinghouse, 5528 Hempstead Way, Springfield, VA 22151. Provides recycled product and market information. (703) 941-4452.

South Carolina Center for Waste Minimization, (803) 734-5360.

South Carolina Clean & Beautiful, 1205 Pendleton Street, Suite 517, Columbia, South Carolina 29201, (803) 734-0141.

South Carolina Department of Health and Environmental Control Office of Solid Waste Reduction and Recycling, 2600 Bull Street, Columbia, South Carolina, 29201 (800) 76 USE IT.

South Carolina Petroleum Council, 1340 Bull Street, Suite 250, Columbia, South Carolina 29201, (803) 799-9588.

South Carolina Recycling Association, P.O. Box 7464, Columbia, South Carolina 29202. (803) 252-9250.

South Carolina Wildlife Federation, 715 Woodrow Street, Columbia, South Carolina 29205. (803) 771-4417, FAX (803) 771-6120.

The Nature Conservancy, 1815 N. Lynn Street, Arlington, VA 22209. (703) 841-5300.

The Sierra Club, 730 Polk Street, San Francisco, CA 94109. (415) 776-2211.

United States Department of Energy, Washington, D.C. 20585. (202) 586-5000.

Superfund Hotline: (800) 424-9346. Provides information and compliance requirements.